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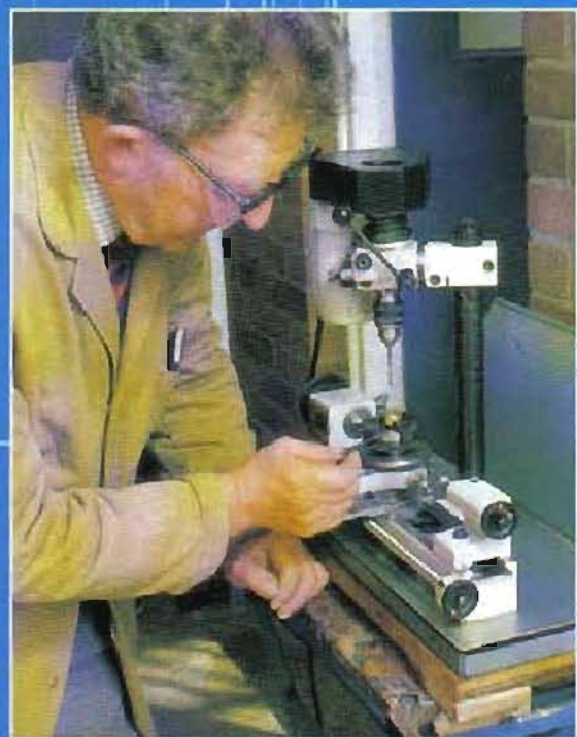
MODEL ENGINEERS'

WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

A DIVIDING DEVICE

Made on the Unimat 3



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Universal Milling
Attachment

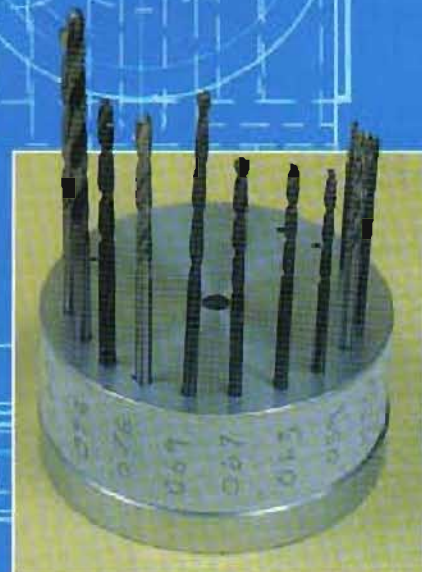
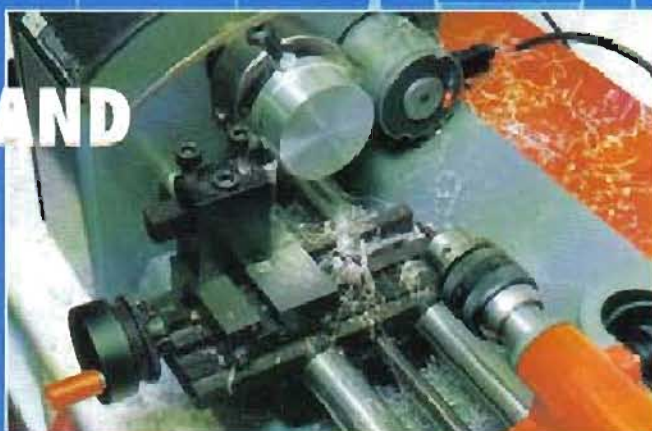
**FREE
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A 'Jeclanide'
novelty handwheel

WHITE-METALLING BEARINGS

MAKING A DRILL STAND

On a small lathe

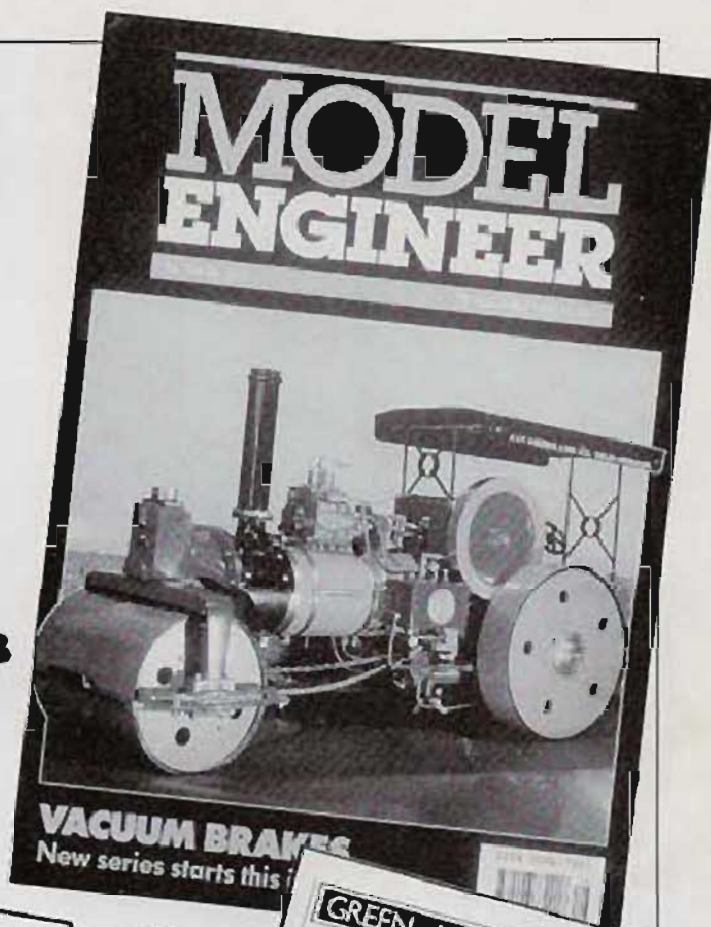


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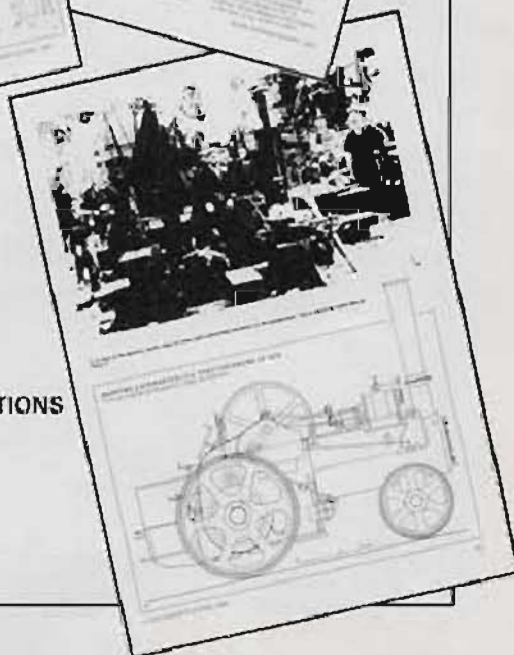
**SOMETHING
TO LOOK
FORWARD
TO...**
...every fortnight



There's something to anticipate twice every month in fascinating Model Engineer magazine! Whether your interests lie in live steam locomotive models, traction engines, internal combustion motors or stationary engines, world famous M.E. will inspire, instruct, advise and encourage. Model Engineer is published on the first and third Fridays each month and costs just £1.40 from all good newsagents; alternatively, you may care to ensure your regular copies through an annual subscription - a mere £33.60 for UK readers (overseas rates and airmail details on request).

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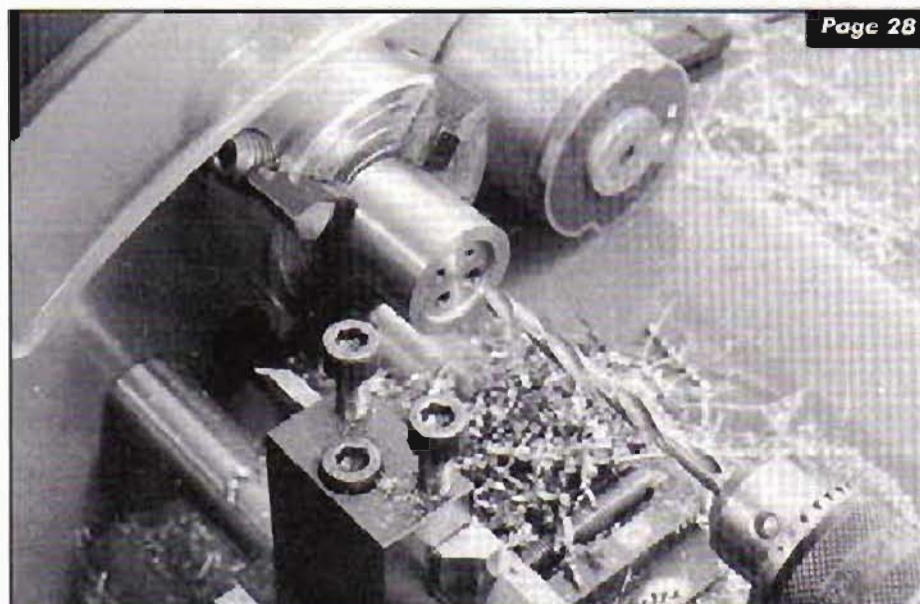
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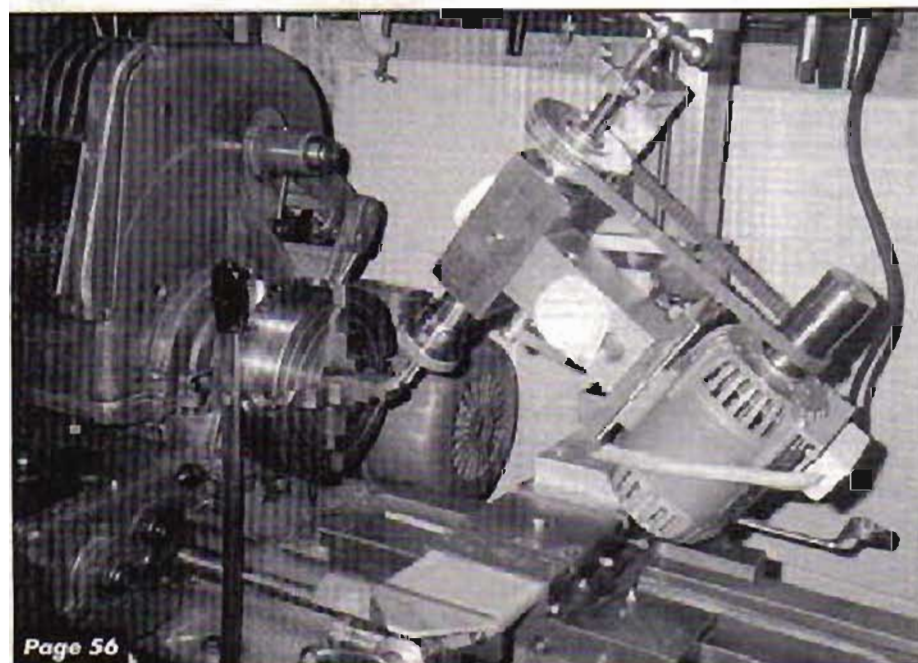
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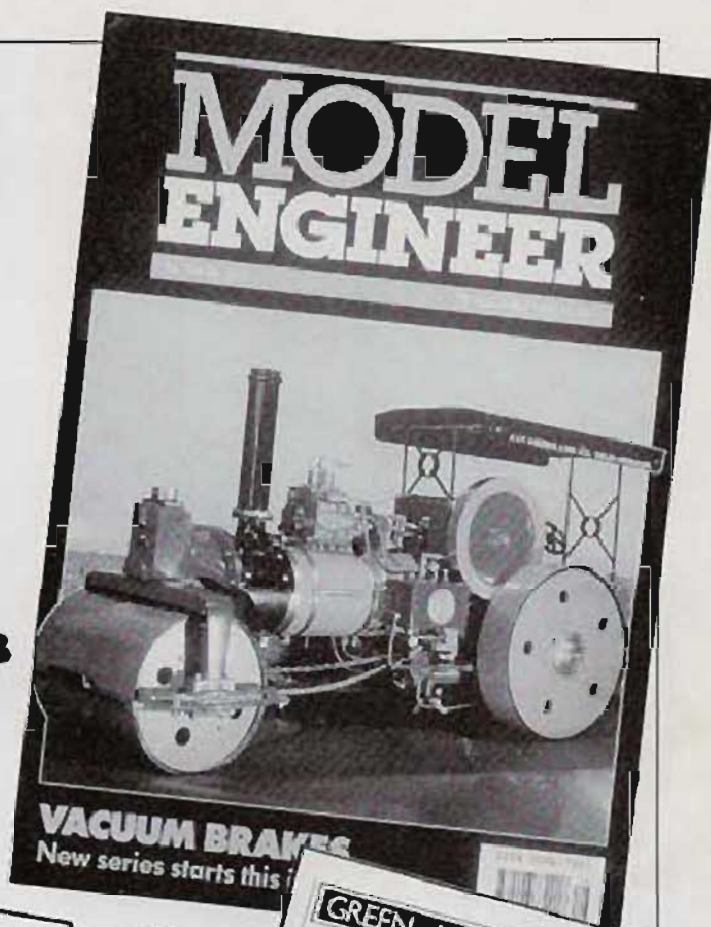
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SOMETHING TO LOOK FORWARD TO...

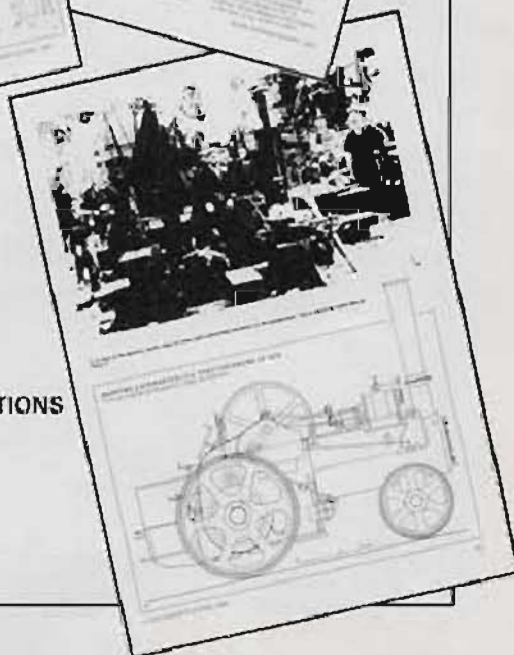
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Harold Hall

ON THE EDITOR'S BENCH

In this issue we present a major article relating to a project which has been requested, with one exception, by a larger number of readers than any other subject. This is a milling attachment for fitting onto a small to medium size lathe. The one in this issue is particularly adaptable, as can be seen from the examples illustrated by the numerous photographs included.

The unit is sized to suit a lathe of about 3 1/2 in. centre height or larger; it would of course require scaling down for use on smaller machines. This should not present much of a problem to anyone capable of making such an item. The design is also capable of some simplification and this may be of benefit to anyone making it for one of the smaller lathes, say a Hobbymat MD65.

Another article in this issue is the Jeclanide Handwheel, an item of no practical use other than to act as a talking-point for those with an enquiring mind. It does though provide some interesting machining operations that will make it an absorbing project. As we are coming up to the Christmas period why not decide to make one or two or even more to give as presents to those who appear to have everything and for whom buying a present can be quite a problem?

If you decide not to make this item, do read the article as it is both amusing and presents a problem to the reader to determine how it works. I only wish I had the time to make one myself...

Sources of supply

The Sources of Supply feature, now included in each issue as part of the Trade Counter, brings in a wide variety of requests from readers. In some cases I am myself aware of a suitable supplier of the material or service, but still publish the details as this may bring to light other potential sources.

In other cases, I have no knowledge of a supplier and as time is in short supply make no attempt to locate one in the many catalogues I have to hand. The recent request for square silver steel was a case in point.

This request came from a number of readers, most I must say through the recent reader survey. As I had not purchased square silver steel for very many years, still having a stock available from that time, I

considered that perhaps this was no longer available from suppliers to the home machinist. This thought was reinforced by the fact that it was not an isolated request.

Readers will be aware that when this request was published, the answers received indicated that it was listed in the catalogues of a number of suppliers who advertise in this magazine. This has led me to believe that perhaps readers do not make as much use of suppliers' offers to provide catalogues (usually free). So if your library does not include a good range of catalogues, why not make a point of browsing through back copies of *MEW* and sending for some. Do please mention *Model Engineers Workshop* in your correspondence.

Comparative testing

Many readers have, by letter or through the recent reader survey, requested that *MEW* should contain reports on items of workshop equipment, in much the same way as the Consumer Association does through its "Which" publication. This would indeed be a very interesting and useful feature - it is though unfortunately not practicable. If one considers the fact that *MEW* is published only six times a year at a cost of £2.50 and has a relatively small circulation, then it is obvious that the total amount of money generated is not that great.

When considering that this cash has to be shared between the authors at one end and the newsagent at the other and everyone in between, it should be obvious that tests consisting of tens of thousands of pounds are just not on.

If the testing of, say, lathes of about 3 1/2 in. centre height were contemplated, it would only be fair if all those of apparent good quality were tested. Testing could only be carried out realistically if these were properly installed, that is levelled, etc. with some dismantling to determine the quality of hidden aspects, bearings sizes typically. In all, it could be a very time consuming exercise.

From this it should be obvious that if these were included the cost of *MEW* would have to rise substantially. The effect of this would, without doubt, reduce circulation and thereby force the price up even further. I do hope this explanation goes some way to explain to those readers who have made this request, why such reports are not practicable at the present time.

As an alternative though, reviews of individual machines will be undertaken and that for the Emco Maier Unimat PC in this issue is typical of what can be expected.

Answer this question

A reader has offered an article relating to the adding of a flywheel to the final pulley of a mill/drill. This, he states, improves the results obtained using his relatively cheap Taiwanese Mill/Drill. In correspondence with him I questioned (having my own thoughts on the subject) why this should be. To this, he replied that the idea was largely as a result of reading an article on adding Poly 'V' Belt drives. This article was published in *Model Engineer* during late

1990 and early 1991. At the time he had given it little thought as to why the improvement occurred, but proceeded to add the flywheel and found that it proved to be so. As a result of my question he had given it some further thought and his reply to me was largely in agreement with my own ideas.

The author of the *Model Engineer* articles makes very little comment as to why the flywheel improves performance, but does refer to the operation of negative rate milling being particularly assisted by its addition. I must admit that this term, negative rate, is new to me and could not be found in the various text books viewed on the subject. Should this read 'negative rake'? (though if a typographical error it does appear twice in the article).

Now for the question: Has any reader technical knowledge, or first-hand experience, of this situation to explain why the addition of a flywheel will be of benefit? In particular will it noticeably benefit the situation with all sizes and types of cutters or is it only beneficial with larger cutters, particularly flycutters?

I would like to receive your ideas on the subject be they practical, technical, or even mathematical. Perhaps then I could publish them in the same issue as that containing the article.

This month's request for articles

This month's request for an article relates to a minor failure in providing a feature for this issue. There has been, in the last three issues, a series on Milling for Beginners which has been published as was originally envisaged - that is relating to milling using a milling machine. It was then planned to extend the series to a fourth part, *Milling in the Lathe*, and this final part to complement the universal milling attachment article also in this issue.

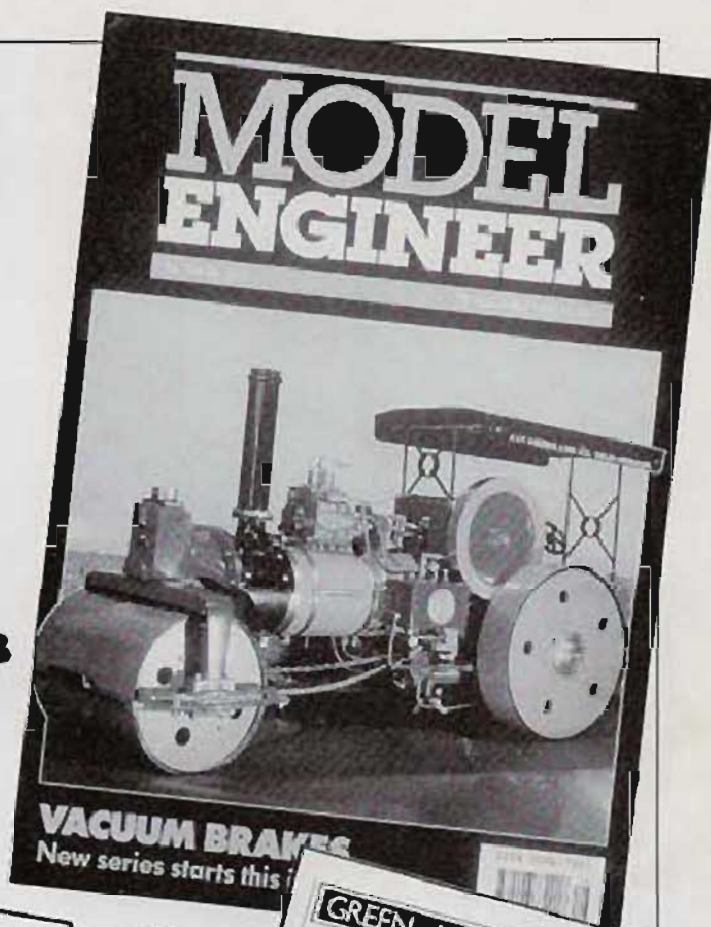
Due to some very time consuming personal problems and the fact that I do not mill in the lathe very often in my own workshop. It was not possible to prepare this article. However, it occurs to me that there will be some readers who do all their milling on the lathe, and as a result would be in a much better position to contribute this item!

As the actual milling operation is not that different whether it is carried out on a milling machine or a lathe, it is largely a case of differences in set-up. For this reason the article would require to be highly illustrated. Obviously, to achieve this, photographs would require to be taken as different types of work are undertaken and over a long period of time. This would be OK as it is unlikely to be published until well into 1993.

It should revolve around the use of the vertical slide and small milling spindles, etc., and not the use of manufacturer's add-on vertical heads. When fitted, these only create the equivalent to a small vertical mill, an area which has been largely covered by articles so far published.

Any readers who feel they could become involved in this should contact me before proceeding. If no reader feels in a position to produce the complete article, it may be possible to make it a joint effort. In this case, if any readers were prepared to provide only photographs, I or another could probably provide the text.

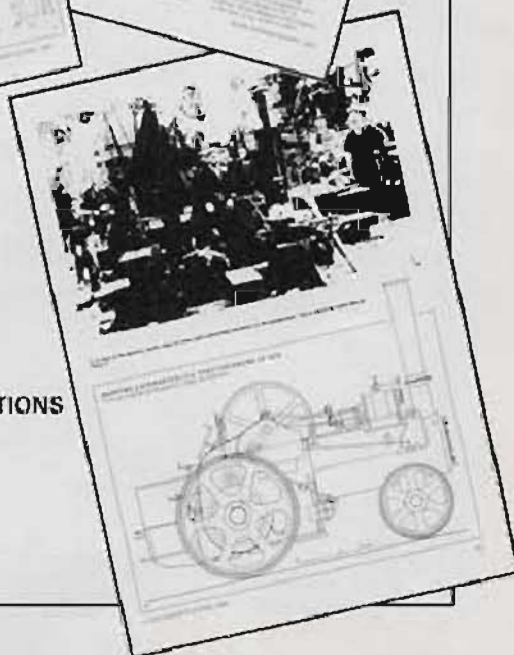
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SCRIBE A LINE

Your views, your pages! Your opportunity to make your point, ask the question or simply pass on a snippet of interesting advice to others. Your letters for publication in *Model Engineers' Workshop* are always welcome

Electric Furnaces

From Mr M Pitcher of Henley-on-Thames, some advice on making an electric furnace.

In reply to your request for information about electric furnaces, I can only give some negative advice.

Many years ago, when *Model Engineer* was a small weekly publication, there was a brief interest in such things. At that time an electric room heater was available, consisting of a circular bowl - often coppered - with a central heater element, a wire spiral wound round a hollow ceramic support an inch-plus diameter by about 3 to 4 inches long.

I made a muffle by wrapping one of these elements in asbestos and slag-wool, but its life was extremely short, the element burning out through overheating. End of muffle!

Such spiral elements needed very careful assembly anyway; the spacing of the individual coils had to be just right, a couple of loops too close together soon led to a burn out. Tempering temperature control was going to be through a cooker Simmerstat switch. I wonder where I've put that switch!

Tailstock die holders

Mr H Harris from Warrington suggests a simpler tailstock die holder.

Recently, while turning the parts for the tender pump for the 5in. gauge model of Lion which I am currently working on, I realised I had a need for a tailstock die holder to screw stub ends up to the underside of the hexagon heads.

I remembered an article in *M. E. Workshop Issue 9* by D Watkins. Because I required the tool quickly I made a simpler one. With apologies to Mr Watkins, I decided not to bother with turning a Morse taper shank.

I had a piece of 2in. dia. MS stock 2in. long which I faced and trued up. Once set up I used a 3/16in. dia. drill, held in the tailstock chuck, to drill along the length of the holder. After boring one end to take the relevant die, the holder was drilled and tapped to accept three 1/16in. screws. A 4in. length of 1/16in. dia. bright MS held in the tailstock chuck provided the arbor to locate the dieholder. The other end of the holder can be bored out at some later date to accept another die when the need arises.

The tool I have just described was quickly made for a special purpose and it works perfectly.

Congratulations on a very readable and useful magazine.

Screwcutting wisdom

In this letter Mr D.R.W. Wootton of Luton highlights the minimal error which frequently results in cutting metric threads with imperial lead screws, and the reverse.

Re June/July issue of *MEW*, *Scribe a Line*, p.7, perhaps Mr Sawyer has not read Martin Cleeve's *Screwcutting in the Lathe* (Argus Books). Considerable information is given about cutting metric screws with imperial leadscrews - but - and it is a big but - it deals with the common English change wheel system 'by fives'. I seem to have read somewhere however that American lathes often have change wheels 'by fours', and Mr Sawyer does mention a 48 tooth gear.

A further consideration is whether Mr Sawyer needs to have his screws spot on accurate, in which case the 127 tooth gear is essential, or whether some very small degree of inaccuracy is acceptable. In some cases Martin Cleeve's approximations give errors as small as one part in 8000; perhaps it might be possible to get as close with gears by fours.

Filing in the lathe

This letter from Mr R. Knee of Lowestoft considers filing in the lathe (with care) an acceptable practice. What are your views?

I have recently been introduced to *MEW* by a gift of some back numbers and have now become a regular reader.

In one of the back numbers, for Feb/March '92, the article on filing rests (p.20) severely censures the use of the file on rotating work. It is unlikely that your esteemed contributor has ever been employed as a turner on piece work.

I use a dead smooth file for final sizing of ringless cast-iron pistons for model petrol engines, with the work rotating in the lathe. This is easier and better than using a lap; there is no need to make a special tool (Delapena no longer make external laps) the undesirable introduction of abrasive material is avoided, and the consequences of a hand-held lap seizing, as they are prone to do, are far more

unpleasant than those of any probable filing mishap.

The man who introduced me to this method has been using it since the 1930's. His competition engines have achieved notable success in racing hydroplanes and his 4-cylinder scale petrol engine took the Edgar T. Westbury Memorial Trophy at a recent M.E. exhibition. Filing in the lathe, with care (and a handle!), is not such a heinous offence after all.

"Why don't they?"

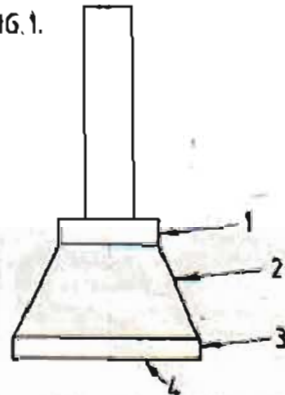
Frank Chambers of Newport, Ireland, sends in this idea; I will be happy to comply if you, the readers, send in your questions. Manufacturers may like to reply with their reasons why they don't ...

Why don't "they" (that's you) have a column called "Why Don't They ...?", which prints submissions from staff and readers for new and revived products. Manufacturers who took up any of the ideas would have no legal obligation to the submitters but would have a moral obligation to send them a sample when the product came to market.

Here are some suggestions for a start:

1. Why don't they manufacture dovetail cutters, countersinks, and the like with standard length shafts and threads compatible with the Clarkson Autolock and similar chucks?

FIG. 1.



2. Why don't they make dovetail cutters like Fig. 1, with four cutting edges, to avoid the thin pointed bits which are weak and have a tendency to crumble? This would apply for woodworking as well as metalworking.

3. Why don't milling machines have a slideable magnetic rule instead of a fixed rule to measure gross table travel? Then all controls would have an adjustable zero setting. This could also be done as a retrofit for popular mills.

4. On milling machines with fixed rules to measure gross table travel, why don't the rules have the same units as the handwheels?

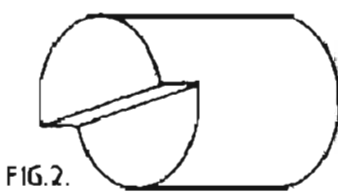
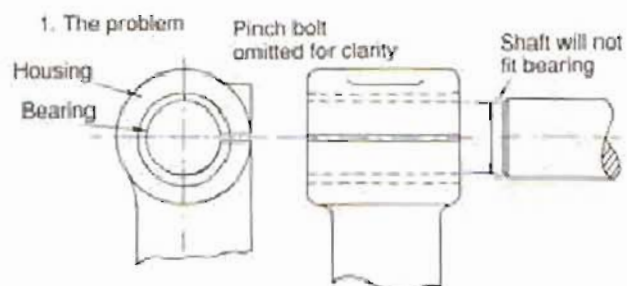
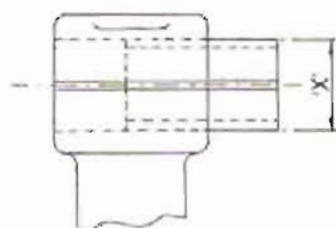


FIG. 2.

5. Why don't they make a lathe tool centre height gauge which plugs onto the tailstock barrel? Fig. 2 is a sketch of one such which has served me well for many years.



2. Determine Housing I.D.



Insert bearing halfway into housing measure outside diameter of bearing to get inside diameter of housing dimension 'X'

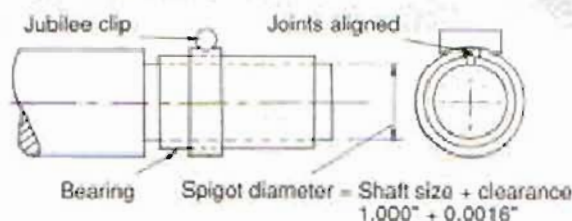
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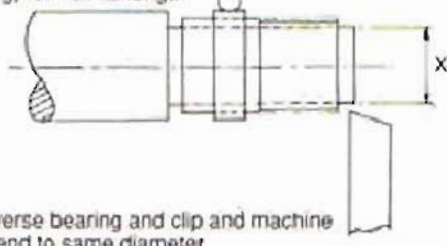
Measure shaft diameters at D1 and D2 (position of bearings). Look up the required clearance in tables. In my case the shaft is 1.000" and so precision running clearance is 0.0016" (Can a lathe run with such a clearance? Does any reader have the knowledge to comment Ed.)

4. Turn a spigot to shaft size plus clearance e.g. $1.000" + 0.0016" = 1.0016"$ Do not remove from chuck

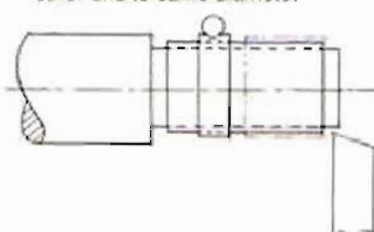
5. Put new bearing onto spigot and secure with jubilee clip. It is important to remove all traces of swarf grit etc. from both bearing and spigot. Correct seating is vital. The bearing must be positioned so that the split is next to the joint in the jubilee clip then tighten the clip hard, it must not spin during machining.



6. Turn down outside diameter of bearing to dimension 'X' (internal diameter of housing) for half its length



7. Reverse bearing and clip and machine other end to same diameter



8. Repeat procedure for other bearing including measuring shaft and housing diameters

Food for thought

Mark Burgess of Otley sent in this interesting letter on a number of subjects.

I thought that you may be interested in the method I recently used to reduce the thickness of some plain bearings which were supplied oversize.

The bearings on my lathe take the form of a letter 'C', any adjustment for wear being taken up by a pinch bolt in the housing. When the main shaft was assembled with the new bearings it was so tight that it could not be rotated by hand.

I have no accurate means of measuring an internal diameter so I decided to reduce the bearing thickness by removing metal from the outside diameter rather than the bore. This method has several points to commend it. Firstly, the original surface finish as produced by the manufacturer is retained, as is the size of the oilway, so the performance of the bearing is not impaired. Secondly, the machining and measurement are easier to perform. Thirdly, concentricity is assured providing the spigot is not removed from the chuck.

Unfortunately the chances are that only one lathe will be available, the one being repaired, so this machining must be done on some other machine, probably a long way away!

It is important to repeat the full procedure on all bearings replaced, there may be slight differences in the various diameters.

I tried writing out the procedure in full but the accompanying diagrams were easier to produce and are I hope easier to understand.

I have been taking your magazine for

about a year now and generally find it interesting and informative. I had intended replying to your questionnaire but due to pressures at home and at work ... etc.

I have a formal engineering education and am now involved in production engineering, which though not directly related to the needs of the amateur does require the application of certain basic skills when designing jigs, fixtures, machines etc. I have also been able to work with men who have considerable practical experience. This leads me on to ideas for articles you may wish to instigate.

1. Basic rules of thumb when designing e.g.

i) bearing sizes, diameter to width ratio
ii) positioning of holes, how close to the edge of a plate or casting
iii) standard proportions of bosses, keyways etc.

2. Properties of materials: bright bar black bar (coming soon, Ed.), brasses, bronzes, light alloy even stainless steel. Tips on machining e.g. the effects of milling one side of a piece of bright bar to reduce the thickness.

3. Bearings: roller, needle, plain etc. Why plain bearings should be a different material to the shaft.

4. Lubricants: oil versus grease

5. Basic fitting skills: I enjoyed the article on hand scraping but also never underestimate the versatility of the humble hacksaw and file. I made a cross slide for my watchmaker's lathe with these tools, and it works.

Finally may I make a small criticism on some of the designs that have featured in your magazine? The appearance of several

items could have been improved dramatically if the corners had been chamfered or radiused, e.g. toggle clamps, adjustable filing rest, vice positioning device. Chamfered edges and radiused corners are kinder to the knuckles as well. I realise it is only a small point but I do think that the end result is more 'professional'.

Thank you for an interesting magazine, you may have considered some of the ideas already, but there might be some food for thought.

Ball Handles

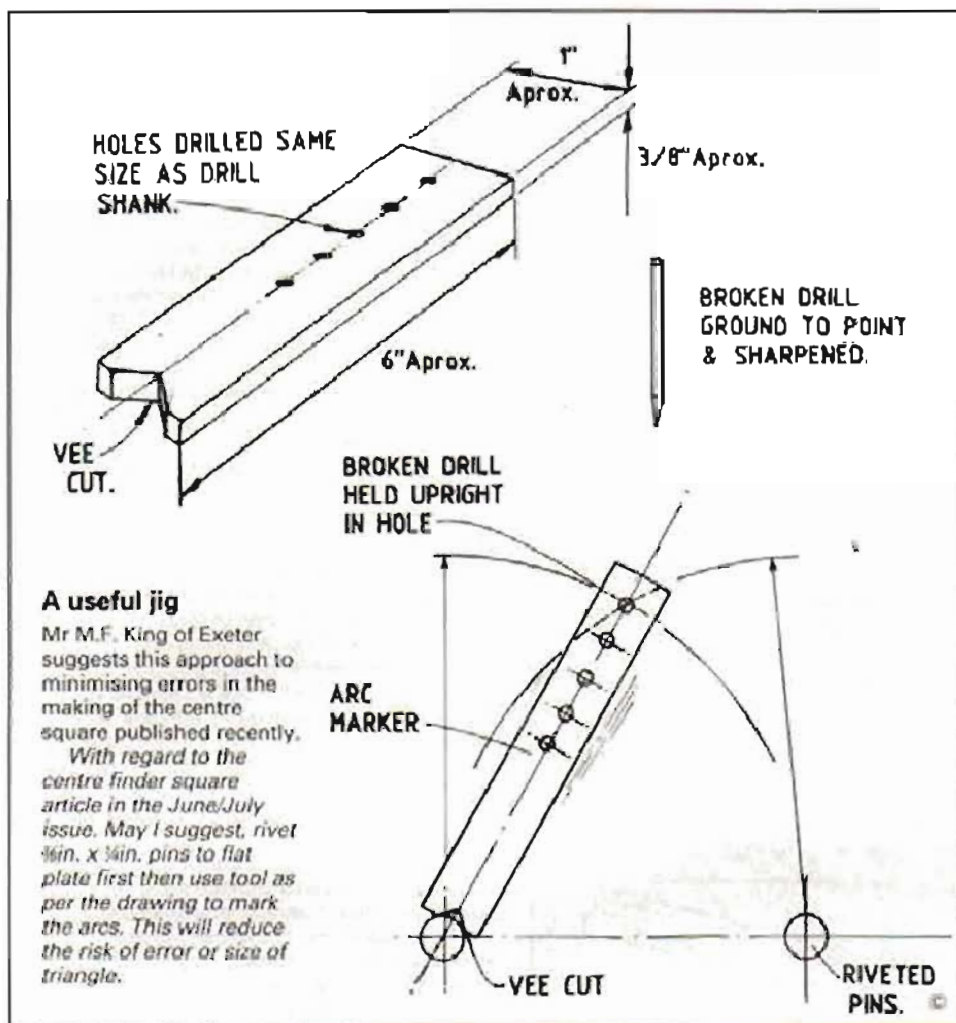
In reply to my request for comments on ball handles, Mr A.S. Hussey of Bexhill-on-Sea makes the following observations.

You ask for any comments on the subject of ball handles. Has anybody visiting a machine tool exhibition in the last say twenty years seen a manufacturer exhibit a machine with ball handles?

It would be laughed at, although I would say here that I believe that there is still one well-known British manufacturer of machines for model engineers (who shall be nameless) who still fits one. Tradition?

The making of ball handles is certainly good practice for beginners and an introduction to ornamental turning and work holding. Perhaps now we can have an article on modernising older machines with ball handles? Will some enterprising firm supply castings for modern style handles?

May I say how much I like the magazine and hope the standard of articles can be sustained. Could we please have reviews and testing of some of the machines on offer?



Linear encoders

Some new ideas on the subject of linear encoders for use with digital readouts are suggested in this letter from Mr P. Hardwick of Lochinver.

I would like to congratulate you on an excellent publication, which I have taken since Issue 1, and have recently renewed my subscription for a further year. I am an automation engineer, semi-retired, but still designing, and manufacturing small special purpose machines for companies who know me from the past. I have a fairly well equipped workshop, and can probably afford to spend more on equipment than the average model engineer. However the cost of 'industrial' equipment is still high, and I have found that equipment designed by model engineers for model engineers is excellent and a lot cheaper, particularly if you make it yourself.

I was very interested in the article on the Digital Readout system, and as your contributor mentioned using linear encoders avoids lead screw backlash, when travelling in either direction. There was a commercial system with a mechanical readout, which avoided using a rack and pinion. A strip of soft metal was mounted along the slide, a hardened wheel (rather like a knurling wheel) was held against the softer strip under pressure. The spindle on which this wheel was running was in a fixed position relative to the slide. The slide was then traversed back and forwards allowing the wheel to cut its own very fine rack. The wheel was then kept under pressure at all times so as not to dis-engage.

Reading that article has got my brain.

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box going! I have started to design a system where the input from such a wheel would be used to drive a gear train, which would finally drive a slotted disc as described in the article. The dia. of the wheel should be such that after a slide travel of 1in., the wheel turns exactly one revolution. A gearing of 10 to 1 with a 100 slot disc would then produce an output in thous. The problem could be in manufacturing the wheel to the precise dimensions required, so instead of gears, use a miniature belt and pulley system, as found in tape recorders. The system is carrying no load, so as long as a third pulley is provided to give constant belt tension, it should work. This means that the accuracy of the knurled wheel is not critical, as the dia. of the largest pulley can be altered to bring the system into correct measurement on a trial and error basis. With this method you can easily produce a metric readout even if the leadscrew is imperial, or the reverse.

I also noticed in my Electromail cat. that there is a ready built add/subtract counter for approx. the same price as the components to build the counter described in the article. It would accept signals from a disc, but the signal for change of direction can be given by a mechanical switch, as de-bounce circuitry is integral. In fact it would accept input pulses from mechanical switches instead of the disc, for measurement purposes, but at a much reduced speed. You would not be able to traverse faster than 1in. in 30 seconds.

Again thank you for an excellent magazine, and my thanks to the contributor of Digital Readout for the stimulation. Luckily I have most of the components to build the electronics already to hand, so the experimenting can go ahead with very little outlay.

Wind generators

A number of readers have replied to the letter from Mr Curry published in *Scribe a Line* (Aug/Sept issue) with the same suggestion. Here are two.

From Mr S.A. Rowe of Warminster.
With reference to the letter from Mr W. Curry of Pembrook regarding wind generators. He should contact the Alternative Technology Centre at Linygwen Quarry, Machynlleth, Powys, Wales. 0654 702400. They will be able to supply information on wind generation; some years ago they used to sell plans of various designs of wind generator.

Also try the local library for some books:
1. Small Scale Wind Power by Dermot McGuigan and published in 1978 by Prism Press of Dorset.
2. The Generation of Electricity by Wind Power by E.W. Golding and published in about 1955. If my memory is correct there were detailed sections on 12v, 24v and 36v systems. To obtain a copy try the book-finding service.

I enjoyed the article on MIG welding as I do the whole magazine. Any chance of an article on oxy-propane and oxy acetylene cutting and brazing, also making broaches?

Also from Mr Walters of Tetbury, on the same subject.

May I strongly suggest that Mr Curry takes a long weekend holiday and visits the Centre for Alternative Technology near Machynlleth, mid-Wales, an area of tremendous interests of all kinds, with plenty of good hotels and B&Bs.

Several types of wind and water

powered generators are on open display working. The bookshop sells designs & info. sheets for many self build projects, it includes sites, calculations and constructional plans.

I think it unlikely that a 12v+ battery installation as described would power more than, say, a wiper motor + 2x20W floro transistorised tubes and sustain this in anything less than a stiff breeze. Perhaps it could drive a Peatol lathe and lights.

If he can't visit then an A4 envelope + 75p will obtain Wind Power, a general leaflet. For £3 you get Scrapyard Windpower Realities, building windmills from odds and ends and plans.

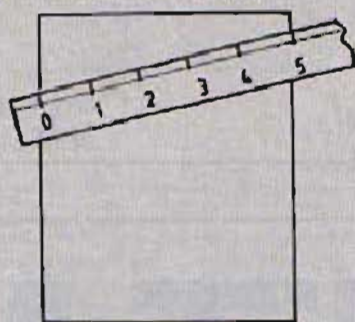
Try also Practical Mechanics, August 1953, p.383, which had a plan for complete installation.

I wish him the very best of luck.

Geometry

C.M.E. from Bristol sends in this simple example of a geometric principle which could have uses in the home machine shop.

A variation of example 3 in Geometry workshop which I used when teaching junior children craft. There was often a need to divide something like a piece of card of random size into strips. The method I used was as in the example.



A piece 4.25in. long to be divided into 5 equal strips. Place the ruler across the card as in the diagram. Line up the 0 with the left edge and the 5 with the other edge. Mark off the points. Do the same at the bottom of the page and connect up the dots. If the width is greater than 5 then choose a multiple of 5 e.g. 10, and mark off every 2 inches.

Plate v Float Flats

As an amateur telescope maker, Chris Forder of Capetown is another illustration of how wide a range of activities is undertaken by readers of MEW. His observations on the flatness of glass are very interesting.

With reference to K.J. Bradbury's letter about plate glass (June/July 1992 issue). I would like to comment on glass and the flatness thereof.

Plate glass is cast, rolled and then buffed. This process tends to give the final surface a rippled finish and, as far as optical quality is concerned, deviates considerably from being optically flat.

Float glass, as Mr Bradbury points out, is made by floating a layer of glass on a bed of molten tin. This process results in a surface which deviates from flat by the curvature of the earth making it a better reference surface than plate glass.

As an amateur telescope maker I have used both plate and float glass for the diagonal mirror on Newtonian reflecting

telescopes and find the quality of the latter far superior. However, I would recommend that those in search of a good flat reference surface make friends with sales or service personnel connected with the photocopying industry. I have found that the aluminised and overcoated flat glass used in copying machines is of a very high standard and that sizes up to A4 (12in. x 8.25in.) and 12mm thick are available if one is in luck!

I wish readers much success in future flat hunting!

White metalling

Fettler, the author of the article in this issue on White Metalling, comments on the detailed letter on the subject by Mr Slade in the last issue.

Re: White metalling of bearings. I read with interest the letter from Mr Slade in the August/September edition of Model Engineers' Workshop describing his memories of con-rod metalling in the motor trade. In the same issue I noticed that you intend publishing next time a remetallling article. Would I be presumptuous if I were to guess that that will be my submission of February last? Either way, perhaps the following will be of interest.

Mr Slade describes most ably part of the equipment which was at one time to be seen in any motor garage workshop worthy of the name. I have used such equipment dozens of times myself and allude to it in my article in the paragraph preceding the sub-heading 'Workpiece Preparation'. The equipment, when fitted to a purpose-built metalling bench and having a treadle release for the jaws of the jig (the latter portion only being depicted by Mr Slade), was called the 'Forwell' jig (there may have been other similar ones). The treadle operated, via a vertical pull-rod and bell-crank, the central sprung rod shown in Mr Slade's plan view (sketch 4). This greatly speeded the work when doing a set of con-rods and caps. In turn, with the whole jig being hot, heat losses were reduced and it left both the operator's hands free to set up each piece for pouring the Babbitt - allowing the jaws to grip the work under the spring pressure as he released the treadle with his right foot.

Mr Slade's letter complements my writings admirably. Perhaps this bit of extra(neous) gen might be of use to someone!

Drilling from the tailstock

John Pooler of Kyle of Lochalsh offers this idea to avoid the requirement to use a centre drill.

It will be particularly useful when making a number of parts all requiring drilling the same size, as it will avoid the need to change from centre drill to normal drill and back.

The article on drilling in issue no. 11 mentions the difficulty in getting the drill to centre correctly when drilling in the lathe. The drill usually finds an off-centre indentation and it then wobbles round with the workpiece.

I am sure that most of your readers know how this can be overcome. In case anyone does not, the problem is easily corrected at the start by forcing the tip of the drill away from the operator using the

tip of the tool in the saddle. As one hand feeds the drill into the workpiece with the tailstock, the other hand withdraws the lathe cross travel. As the lathe tool leaves contact with the drill, the drill is centred. The operation has to be completed before the drill has entered to its full diameter. If an unsuitable lathe tool is currently in use, then reverse it and use the blunt square end of the shank.

The method can even work with a parting-off pip still on the workpiece.

I must add that I always enjoy reading MEW and look forward to its arrival.

Hole crunching

Cliff Dubos, being from Chapman, Australia, is one of our readers for whom delivery of MEW comes quite late. Even so, this answer to a question posed in the April/May issue, is worth publishing for its interesting content and Cliff's excellent illustration.

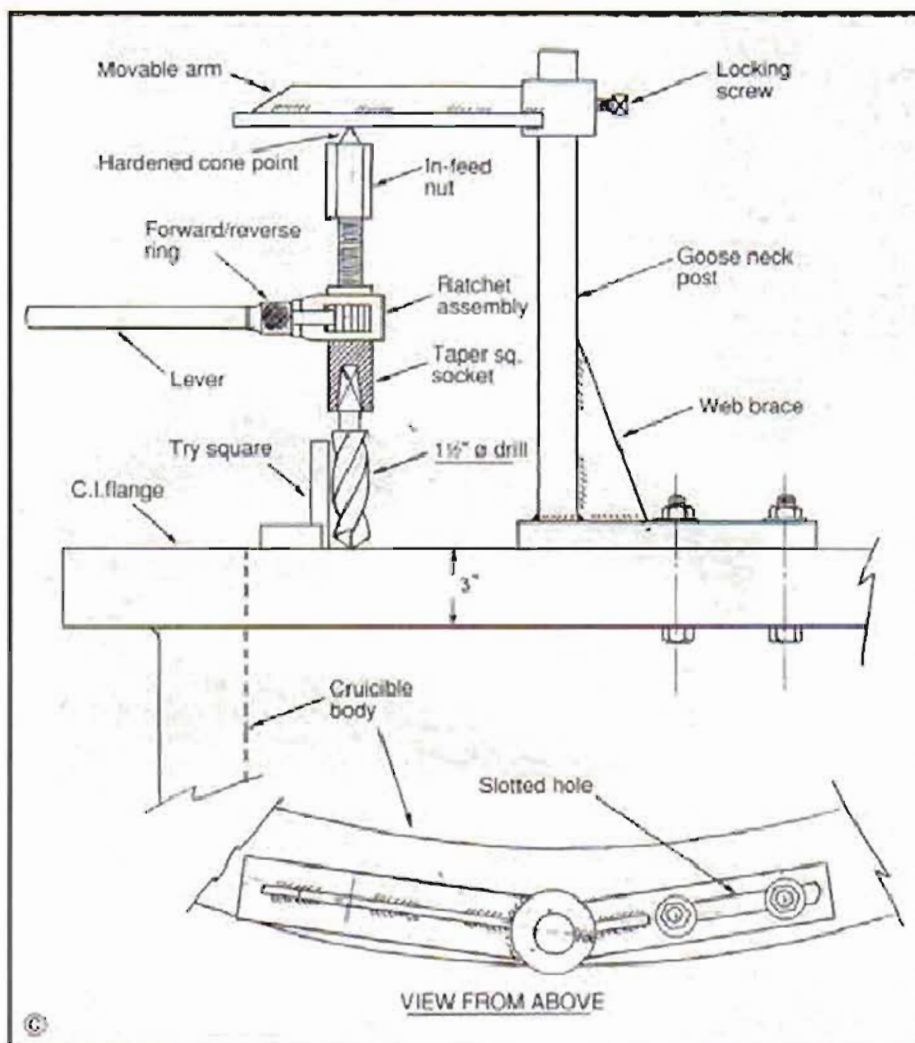
Re: "Odd drills April/May 1992, page 7. As a first year apprentice fitter and turner in 1943 I had occasion to use these tapered square shank drills as an assistant to one of my firm's tradesmen. We were engaged in drilling many 1½ in. dia. holes in the flange of a large cast iron crucible weighing some 13 tons. (I have enclosed an explanatory sketch of the equipment used). A description of the method of operation and a short history follows:

In those far off days the only way that holes of this diameter (in a casting of this size) could be drilled in our workshop was to set up the casting under a large radial drill with the job supported over a pit, or by an air operated portable drill suitably mounted by a "goose neck stand as shown in the sketch. Portable electric drills capable of drilling 1½ dia. holes were not available to us in Australia if indeed they had been developed.

This particular casting was cast and machined in our works but because of its size and a lack of valuable space in our very busy workshop (due to our war-time production) it was moved to our warehouse across the road. Unfortunately this area was devoid of any access to compressed air or machinery except a 5 ton overhead travelling crane. (How we lifted 13 tons with this is another story).

The taper square shank drill used were fitted into a device best described as a lever and ratchet operated chuck (not unlike a carpenter's brace in principle of operation). The unit had an in-feed method based on a very fine R.H. screw thread integral with the drill spindle and a matching long female hex. nut. This nut was blind at the top end and finishing in a hardened cone point that would bite into the gooseneck arm. This hex. nut was advanced by holding with the hand or a spanner as the lever was pulled towards the operator.

The holes having been marked out previously the operator would use a large crater (centre) punch to emphasise the hole centre then mounting the gooseneck in a suitable position on the flange using large "G" clamps to hold the base. The drill and ratchet was set up by using a try square, with the cone point moved around accordingly until this was achieved. The feed nut was then wound up the thread until it indented into the arm. Drilling then commenced by pulling on the lever and adjusting the in-feed nut to keep moderate



pressure on the drill. After the first few holes were drilled the clamps were discarded and bolts through these holes were then used to clamp the base.

It was surprising how quickly you could drill through this 3 in. thick C.I. flange, but if the material had been steel it would have been a different story.

Due to the time difference between publication and delivery here in Australia I would anticipate the question by Mr Sterland has by now been answered. However this letter may be of interest to your readers to show how things were done here in Australia during the war years. Keep up the good work with MEW - a magazine that fills a gap for those of us interesting in building up our own workshop equipment.

A Raglan query

Mr J. Bennett of Brownhills would like some help with his Raglan lathe.

Having obtained from Myford some spares for my recently acquired Raglan 5 in. lathe, I am still in some need of help. As Myfords stopped being actively involved in this lathe back in 1964, the help they can give is limited.

In view of this, I wonder if any reader can be of help with information or even a booklet about the machine? I need to know about drive belt alignment and the details of the range of speeds available. There appears to be a fast speed and a slow speed provided by the gearbox; are there just two speeds?

Nippies

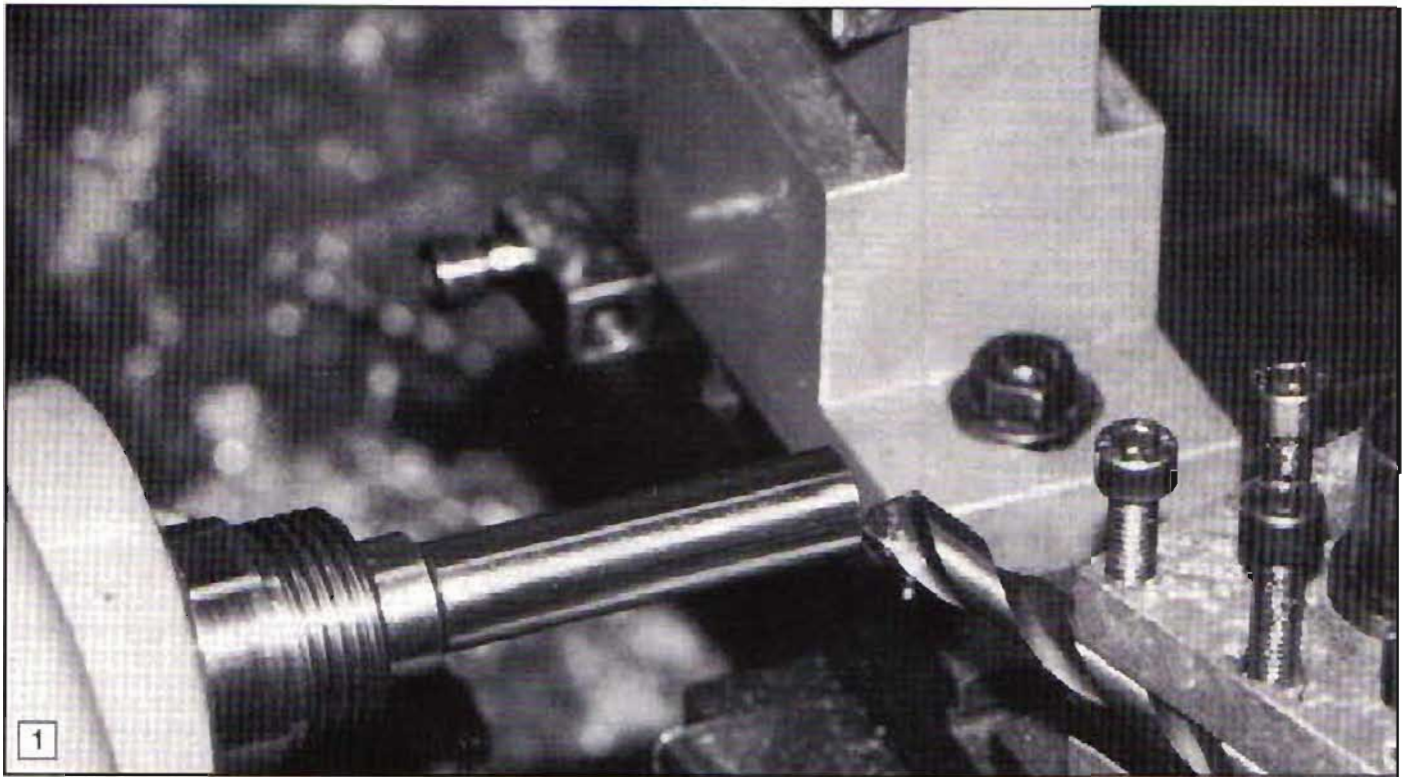
Nick Tyler from Ontario, Canada, would like to locate a supplier of the genuine Nippy vice.

Still enjoying your excellent magazine. Please could you inform me if the Vice (drill) I often see in MEW, namely the Nippy, is still being made? I have not seen a vice in North America to compare.

I would like to pick one up; can you or one of your readers tell me of a supplier in the U.K.? (This vice was made by Murray, Son & Co., Hove, per my 1985 Buyers Guide, but I have been unable to make contact or trace their present location, if any. Can any reader help? Ed.)

QUICK TIP

Have you ever had to transfer a hole, perhaps from one side of a frame to the other, and the frames are not demountable? One idea which has worked for me in the past is to find a bolt of suitable length to fit into the space required, and which will pass through the finished size hole. Set this in the lathe, running truly, protecting the threads with shims. After centring the hole, drill a hole right through the centre of the bolt. Now put the bolt into the hole, and using a long series drill, or an extension drill spot through to locate the hole required on the other side of the frame. With a pilot hole in place it is easy to open the hole out to finished size sure in the knowledge that the holes are aligned correctly across the frames.



TURNING HARDENED STEEL

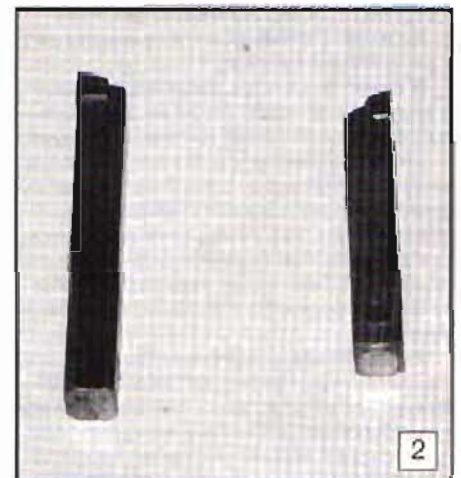
This interesting article on the use of cobalt-titanium tips for turning tools is provided by Yves Rayssiguier of Brest, France.

Those readers who have never had the need to turn hardened steel without the difficult situation, at least in the home workshop, of first annealing and then rehardening after completing the machining operation, can skip this article. Others may be, or perhaps I should say will

be, rewarded by reading on!

The idea being suggested in this article came when deciding to make a kind of ram. This is to be used in the lathe for pushing squarely against the chuck from the tailstock end. This was to be made from a large end mill with a taper shank. Cutting off the fluted end with a fibre disc was easy, but doing this square to the axis was not. To achieve this level of accuracy it really required to be turned and this would necessitate turning the hardened material.

Contrary to some people's belief, it is not possible to turn hardened steel using a



tungsten carbide tool. If it were, then why would the Frheil drill have been developed when tungsten carbide drills were available? From this thought developed the idea of why not attempt to use cobalt-titanium tips, as used on the Frheil drills, to turn the hardened shank.

With the idea in mind a Frheil drill was immediately placed in the tool post of the lathe as can be seen in **photograph 1**. Despite the overhang of the work and the flexibility of the drill, quite acceptable results were immediately obtained. The result was so good that within minutes the tips had been removed from the drill and re-brazed onto two small square shanks, as can be seen in **photograph 2**. The drill having two tips, one tool was made for traversing and a second for facing.

With the new lathe tool placed in the lathe, a very acceptable result was achieved, as seen in **photograph 3**. Following this many tests were carried out on hardened workpieces and, as a result, the following principles established by a process of trial and error.

Speed: Roughly the same as for tungsten tools, i.e. double that used for HSS tools.

Cut: Light



Feed: Rather a high rate

Cooling: Soluble oil

Other home machinists could, no doubt, ameliorate these preliminary findings with their experience gained.

Grinding and honing: It is found that green grit material is acceptable for this purpose.

Cutting and forming: The cutting and forming of the small brazable tips can be done with small diamond impregnated wheels, as seen in **photograph 4**. The larger one was sold some time ago by Proops Brothers (081 861 5258) but unfortunately is now out of stock. However, they can be obtained from a number of suppliers, under the brand name of Minicraft, typically Millhill Supplies (0491 38853).

The remaining item in **photograph 4** is a glass drill, the spade shaped bit of this also being made from cobalt-titanium. These can be purchased from various sources and, in addition to glass, can also be used to enlarge holes in hardened metal.

The idea extended

As with many developments, further ideas follow, these not associated with the original purpose. The thought occurred to me why not use these remarkable tools to overcome a problem I frequently encounter, that is machining materials that tend to work harden with the machining operation. The materials where this problem is mainly encountered are stainless steel and phosphor-bronze.

The results achieved with these

Why don't they

(see *Scribe a Line* Ed)

Most engineers will not be that happy destroying a perfectly good Frhei drill, even if being used to create some other useful item. Therefore at the risk of being called naive, I question why they don't make such lathe tools commercially. Or perhaps does any reader know where the tips can be purchased as loose items?

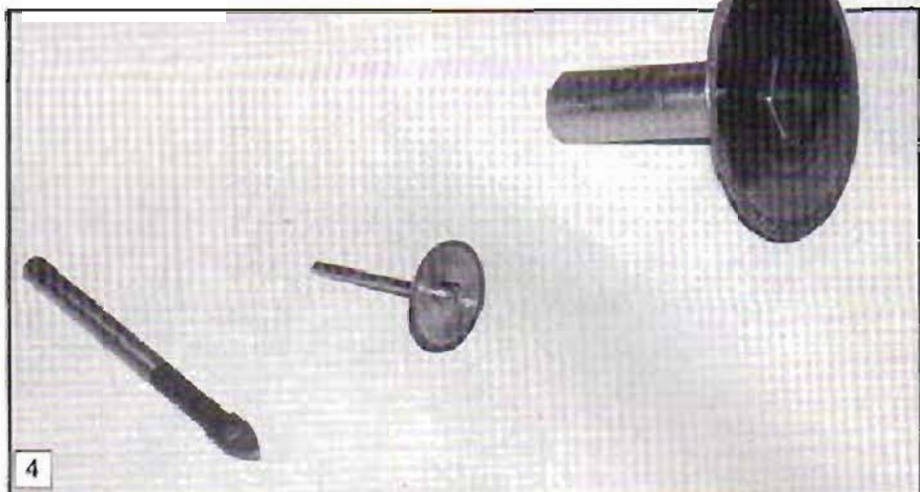
materials were so good that, as so often is the case with new ideas, the secondary idea became the main purpose! As a result this is now my main use for these tools produced from the Frhei drill.

Yet another idea

Since having written the article, I have found the need to create a flat on a hardened shaft, this for the purpose of a seat for a grub screw. Wishing to arrive at a better result than probable by hand grinding, the idea of making an end mill with the Frhei drill tips was considered.

An end mill was made, assisted by the diamond impregnated wheels mentioned above, and the result achieved with these was very good. Further uses have since been found, such that one considers how I have managed without them in the past.

The conditions adopted for using these were: speed 2000 rpm with coolant and a good rate of feed.



MIG WELDING

Following the article in the last issue on the subject of MIG welding, its author, Bill McClean, has added some further thoughts on the subject of shielding gasses. Also included here are two charts which were intended to be published in the last issue - see page 60.

Referring to the article on MIG welding in issue 12 of MEW, I now consider that some additional information on the question of Argon and CO₂ shielding gasses to be worthwhile.

Argon and CO₂ are both available in the

small disposable cylinders at most suppliers. A well known national car and cycle spares stockist offer both gasses at the same price, approximately £11. With industrial gas CO₂ is much cheaper than Argon. Thus, if a lot of welding is envisaged, one could save a few pounds by exploring these areas.

The adoption of different cylinders will mean providing a regulator suited to your cylinder. If going industrial standard, purchase an Argon regulator as this can also be used with CO₂ gas.

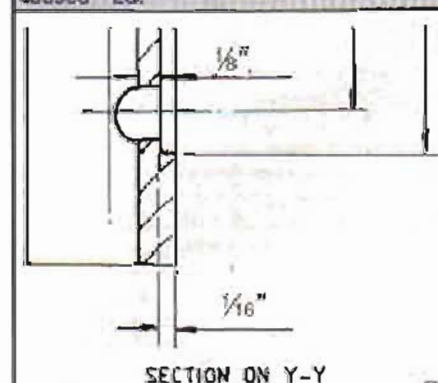
Some car body repair shops used quarter size cylinders of CO₂ for welding. These are generally held in stock at garage supplies wholesalers, who also stock suitable regulators. Exchange cylinders

cost about £9 + VAT and are many times the capacity of the disposable cylinders. Regulators are approx. £20.

It should be remembered that whatever gas cylinder you choose, safety first is the paramount consideration.

IMPORTANT ANNOUNCEMENT

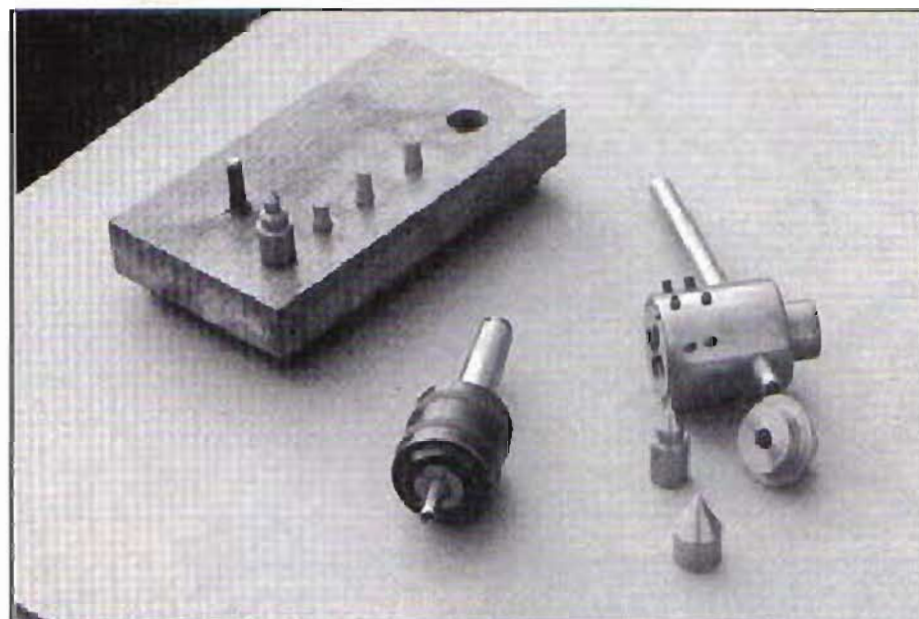
The correction published in issue No. 12 page 68 was unfortunately incomplete. Please work to that shown below. I am sorry for any confusion this may have caused - Ed.



Please amend the position of the arrow as published to that shown. Also change the dimension from 1/8 in. to 1/16 in. as shown. Even if you are not making this chuck yourself please make the changes, it could well save someone in the future, who decides to make it, a heap of trouble. The article was originally published in issue 11 (June/July 1992) - Ed.

M.I.G. WELDING OF STEEL TYPICAL CONDITIONS FILLET WELD: DOWNHAND				
METAL THICKNESS	WIRE DIA. mm	CURRENT AMPS	VOLTS	No. OF PASSES
0.8	0.6	60	18	1
1.2	0.6	80	19	1
3.25	0.6	100	20	1
6.4	0.6	120	21	3
12.7	0.6	130	21	6

M.I.G. WELDING OF STEEL TYPICAL CONDITIONS BUTT WELD: FLAT						
METAL SIZE mm	WIRE DIA. mm	CURRENT AMPS	VOLTS	No. OF PASSES	JOINT DETAILS	ROOT FACE GAP
0.8	0.6	50	17	1	Sq. Edge	-
1.2	0.6	60	18	1	Sq. Edge	1.0
3.25	0.6	80	19	2	60° Vee	1.2
6.4	0.6	100	20	2x2	50° x2 V	1.2
12.7	0.6	130	21	4x4	50° x2 V	3.5



Various of the special noses made for his centre by the author, together with the tailstock dieholder described in this article.

A MODIFIED LIVE CENTRE

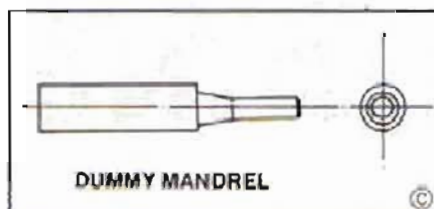
G. K. Bartlett suggests some interesting modifications to a live centre which increase the range of tasks it can perform

This is a simple modification which could be applied to most commercial live centres or indeed could be incorporated into a new scratchbuilt design.

I have a live centre which I purchased some years ago and it has done fine service, the only snag being the well known one that the large body gets in the way sometimes on small diameter work. Also inevitably a certain amount of bruising of the nose piece takes place over the years and to return this to a nice crisp condition entails dismantling of the unit.

It seemed to me that a variety of detachable noses of different sizes and forms would solve both problems and vastly increase the usefulness of the device and this is how the idea started. The following description may have to be altered by the reader to suit his particular centre of requirements and as will be seen I have not exhausted the possibilities by any means.

The photographs show the general idea and also the mounting board on which I keep the bits and pieces when not in use. The parts as shown give two sizes of internal centre, three sizes of standard centres, a tube centre and, as an afterthought, a tailstock die holder. All the centres are silver steel so they can be hardened if desired - I didn't as I find the steel tough enough as it is, certainly harder than the original.



Getting started

The first job is to remove the spindle from the unit; in my case the locking ring was removed and the end cap at the small end of the shank. This enabled the spindle and bearings to be tapped out, said bearings being removed and carefully put to one side. Of course the spindle may tap out leaving the bearings in situ, probably easier. The spindle can now be held in the four jaw or an accurate three jaw plus

Quick Tip

One of the oft repeated pieces of advice given to novice turners is to hold a piece of white paper under the tool when setting up work, e.g. in the four jaw chuck. Fine, but when needed the white paper is never to hand; or the hand to hold it is covered in grease or oil and the paper soon loses its pristine appearance. It is a human failing at that time to ignore what is good advice. An easy answer to this problem is to cut a piece of white Plasticard, punch a hole through it and hang it up by the lathe conveniently for use. It may be washed as required. A cheaper alternative is to cut a section from a white plastic container and use this. Washing-up liquid bottles are good.

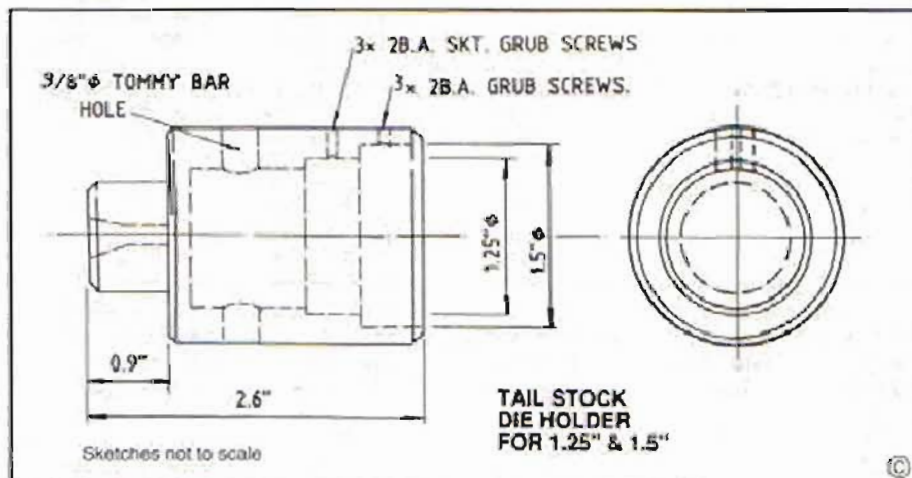
fiddle factor and clocked to run dead true. Turn away the point of the centre until the diameter is about 0.3in. and centre drill fairly deeply and you now have the first nose piece ie the small INT centre.

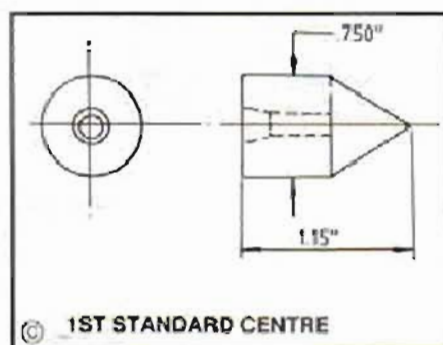
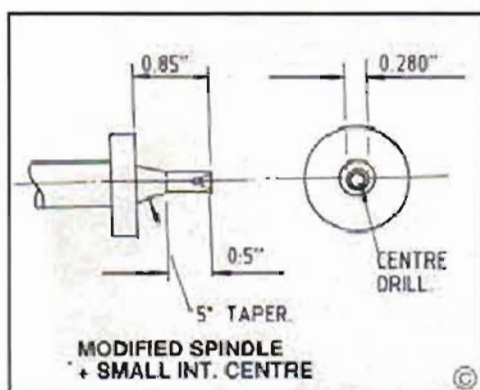
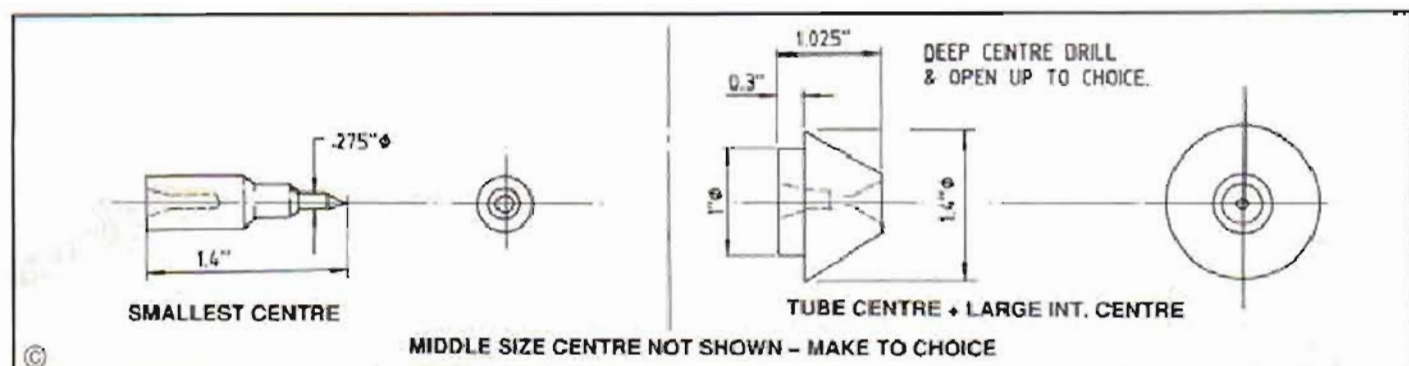
Now turn down to a dia of 0.325in. for a length of slightly over 0.775in. and then down again to 0.280in. dia for the first .5in aiming for a fine finish true to size. Set over the top slide to 5 degrees and leave it locked in this position until the job is done (the actual angle is not critical as long as it is maintained on all pieces). Starting at the half inch step turn the taper aiming for a neat transition from the 0.280in. dia., remove from lathe and set aside for a while.

Dummy spindle

Now we need to make a dummy spindle from any old piece of scrap steel of around three eighths to half inch dia. and a couple of inches long. This should be checked and unless it is perfectly round and smooth the holding length should be cleaned up then reversed in the chuck and an exact copy of the spindle nose piece made. If the three jaw is used the piece should be marked for number 1 jaw in the hope of later resetting to run true. This bit will be used as the mandrel for finish turning any nose pieces we care to make and can be kept for any future additions.

I would suggest now that at least one centre nose piece is made and the one I made was the same size as the original. The procedure is to chuck a suitable piece of silver steel face of and centre drill. Now drill and ream to the 0.280in. size for a depth of say 0.85in. We can now be crafty and if we can reverse the lathe and have or can make a small boring tool with





reversed angles and offset we can put in the taper section of the hole and know the tapers will match. If not we have to use the lathe normally and offset the top slide the other way and fiddle a bit if necessary. Either way keep trying the spindle in the hole until it goes firm on the taper with just a few thou gap between the flat faces. A word of warning; it is not generally a good idea to run a screwed-on chuck in reverse but as long as speed is kept down I can't see any problem from the tiny cutting forces involved here. Reverse in chuck and form the 60 degrees centre just coming to a point.

We can now reassemble the running centre and check the new embryo nose for fit, the idea being to get a good fit on the taper and a minimum of wasted overhang of the original spindle past the locking ring. If all is well we can either finish this nose or make some more pieces to suit what we think we require. To finish off the centres, rechuck the dummy spindle and get it running true then tap on the centre to be finished with the smallest smidgen of superglue on the plain portion (not taper). This will stand the forces involved in taking

the final cut or cuts. The joint can be broken easily with quite a small amount of heat and the remains of the glue teased off with finger nail or a bit of plastic.

Nose pieces can now be made to choice, small dia and longer than normal are very useful and so is a tube centre. The tube centre I made also serves as the large external centres, I simply centre drilled the end with a large centre drill and then when it was put on the mandrel to finish the outer surface I also opened the centre drilled taper portion slightly with a boring tool to restore truth.

Tailstock die holder

The tailstock die holder in my case owes more of its dimensions to my particular requirements plus material availability than to design. I suspect most people would prefer it longer and possibly sliding but as I say the possibilities are not exhausted. I have a number of small thread dies which are in the large body size and had no diestock for these so that dictated the basic size of the holder. I then hunted for a piece of chunky material to make it and couldn't find any. I did however find some (things) I don't know what they are but I call them

piston ring blanks, at least that is what I use them for. They are a hollow round iron casting with a reduced diameter holding spigot at one end and one of these was quickly machined into the die holder.

The hollow section was too large for the smaller size die so it was bored out for the larger and a sleeve made and pressed in to form the step. It will be seen that only short threads can be cut with this tool and in retrospect having the tommy bar passing right through limits it more. A bar brazed in through one wall might have been better but I didn't fancy brazing cast iron.

In conclusion

Finally let me say this has been a most worthwhile modification and I very rarely now use a fixed centre as I can get into almost anything with this device. Nose pieces are held firmly on the taper but are easily removed with a rod passing up the middle. Alternatively a penknife slipped into the tiny gap and given a sharp tap works just as well.

Commercially made centres with detachable noses are available but are pricey so the effort is well worth while. Other noses which immediately spring to mind are tap holders and flat or stepped pressure pads, no doubt other people can think of more. Happy turning!

Quick Tip

If you heat treat by muffle furnace you can reduce scaling of the work considerably by placing several pieces of dry charcoal from the barbecue directly inside the door. This will have the effect of absorbing much of the oxygen which causes scale.

Alan Jeaves

WELDING: GAS·MIG·TIG·PLASMA & COMPRESSORS



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the spring tension and so reducing risk of damage to the plastic pulleys.

Tailstock handles

The Hobbylat uses two Allen keys on the tailstock, one to lock the barrel and the other to lock the tailstock to the bed. These are effective enough but I wasted precious time finding the Allen key each time it was needed. Besides, the Allen key did not feel right for this job, so I set about making handles as shown in **fig. 2**.

The position of the handle in relation to the main body is important on both fittings, so when machining in the lathe was finished, I fitted these onto their relative positions on the tailstock, tightened them up with a strap wrench and then marked the position for the handles. The handle on the tailstock locking device has to be removable for it to fit onto the tailstock body. Rather than trying to tap an angled blind hole, I opted for the method shown in the drawing. I drilled the top end to take an M4 tap, the hole for the handle was drilled, this was inserted and the same M4 tapping drill was used to mark the position for a small locating hole in the 10mm dia. bar. The hole in the main body was then tapped M4 and the handle locked in place.

I fitted the handle at an angle of 5 degrees. In practice this has suited me well but there is no reason why this shouldn't be altered to suit your own hand. Incidentally, the screw thread was my first attempt at screw cutting on a lathe and was an interesting exercise in itself.

The only dimensions that are at all critical are the length of the middle section

Tailstock pointer

Another thing about the tailstock is that when the drill chuck is in place the scale markings on the barrel cannot be referenced to zero because of the length of the chuck's Morse taper. To overcome this, I added a simple pointer as shown in **fig. 3**. Although this modification came to mind early on in my ownership of the MD65, I put it off for some time because, unlike the previous examples, I could think of no satisfactory way of achieving it without in some way irreversibly modifying the lathe. However, I eventually took the bull by the horns and carefully removed the tailstock in order to drill the two necessary holes. One to take the pointer and the other tapped M5 to take the locking screw.

I can say that this simple pointer has proved invaluable and avoids much confusion when drilling to a required depth.

Index scale modification

As I became more familiar with the lathe I discovered another irritating trait. If the handwheels were turned quickly the indexing scales would move, as they are

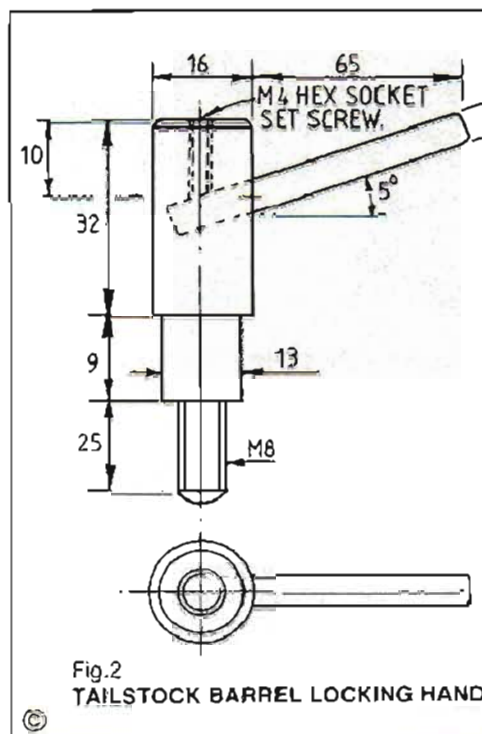


Fig. 2
TAILSTOCK BARREL LOCKING HAND

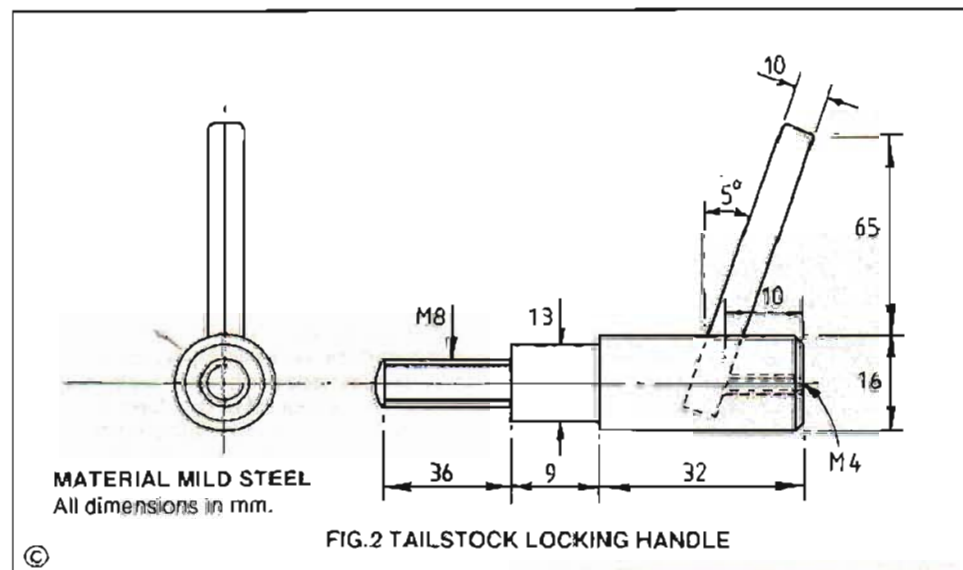


FIG. 2 TAILSTOCK LOCKING HANDLE

TIONS

and the screw thread - Note that this is different for each of the handles.

The result is that the tailstock "controls" have a much nicer feel and to use a modern expression are now user friendly.

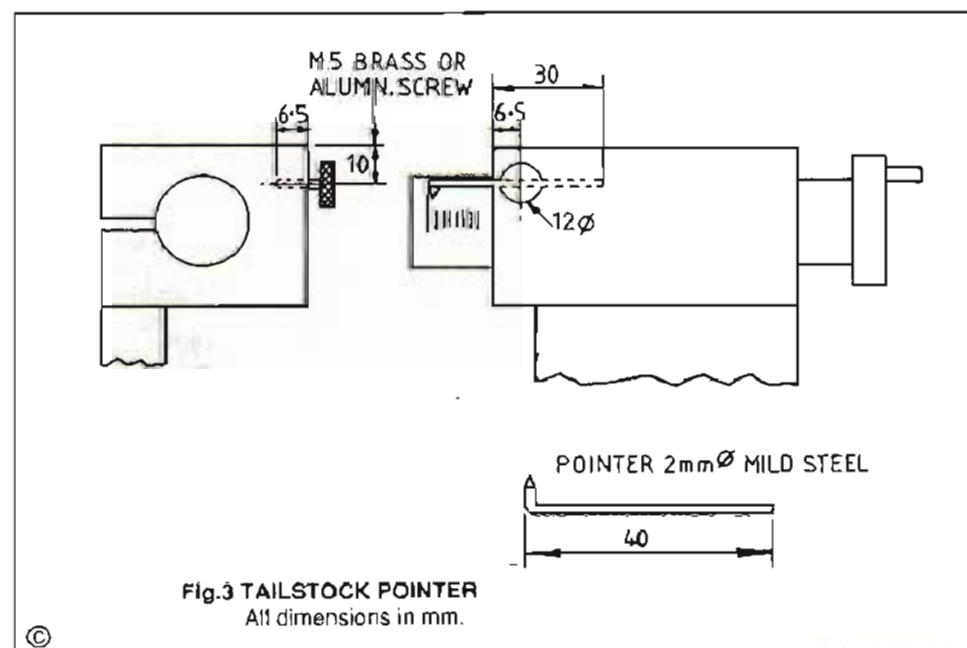


Fig. 3 TAILSTOCK POINTER
All dimensions in mm.

only held in place with leaf springs. I had seen an earlier lathe of the same type and noticed that this one had locking screws on the graduated collar. I put an M5 x 11mm grub screw in each collar just to the right of the zero mark in each of the three scales and this has improved accuracy considerably.

These simple modifications to my machine have added a degree of refinement to a lathe which I think is robust and versatile. When I have added a slow speed attachment and fitted a toolpost which does not tighten up the saddle when a tool is in place, I will have the ideal lathe for my home workshop.

Quick Tip

For those whose wives will let them temper hardened work in their gas ovens, a good conversion from 'gas mark' to temperature scale is: Gas Mark x 11 + 140 = degrees Centigrade.

Alan Jeaves

RENOVATING A COMPRESSOR

In this article Dave Lammas describes his experiences in renovating an old compressor.

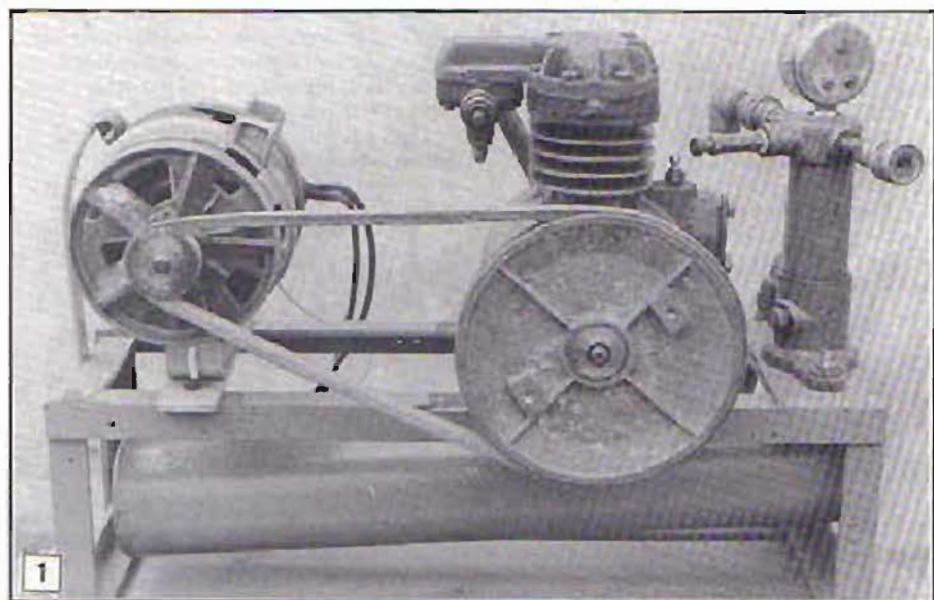
I suspect that most of us have at one time or another seen items of equipment advertised in *Model Engineer* magazine or elsewhere, perhaps even have seen such an item in a fellow modeller's workshop and thought how desirable it would be to own one. The great problem is usually the exorbitant cost of new machinery which means we just carry on without it. Occasionally however an opportunity presents itself in the form of an offer 'too good to refuse'. This may be a bargain secondhand piece, something found at the scrapyard or as in the case to be described a lump of someone else's discarded junk.

It so happened that my neighbour, a model engineer with magpie instincts, had over the years collected together an



2: The compressor with the head removed. Note how close the bores are together.

enormous amount of junk that had mostly been put to one side with a tatty label saying Future Project. That the future never seemed to materialise for some of it was beside the point. Anyway it came to pass that demands of 'The Job', you know, the boring time that has to be spent away from the workshop in order to accumulate money that must be frittered away on the cost of living, necessitated moving house. The mere thought hit him like a blow between the eyes ... "how on earth am I going to move it all, the removal firm won't touch that stuff with a bargepole". When the sad day finally dawned there was still



1: The complete compressor, seen here fitted with temporary wiring, and with the belt guard removed for ease of viewing.

quite a heap in the garden and he desperately said "can I put this lot over the fence for you to sort through? Chuck away anything you don't want". See what I mean about an offer too good to miss? on second thoughts perhaps not since it took an age to cart the rubbish off to the dump.

One of the more recognisable bits turned out to be some sort of small air compressor complete with pressure gauge and tank. It lacked a motor and had been robbed of its drive pulley but a coat of sickly green paint had been poured over the rust at some time so it seemed to have possibilities. In the course of restoring it to some degree of usefulness the thought occurred that the procedure followed might be of interest to the less experienced home machinist so some photos were taken for a possible article; this is the result. **Photo 1.**

The first step

Even if it looks good one is forced to ask the questions "Do I really need it?", "What can I use it for?", "Will there be enough room in the workshop for it?". This does need serious thought because all too often one sees equipment purchased in a burst of mistaken enthusiasm just rotting in a corner. On the other hand new modelling possibilities may be opened up or better ways be found of tackling jobs previously found to be unsatisfactory.

Although question 3 proved to be something of a problem the answers to number 2 made the effort to re-arrange the workshop worthwhile. So just what use is a compressor? First of all in the interests of safety one must say that using compressed air to blow away dust and swarf is highly dangerous to man and machine, although

one often sees such practise described. Blowing dust around makes it very likely that it will be breathed in with potentially disastrous results to the lungs, grinding dust is particularly bad in this respect and it should not be forgotten that such apparently innocent material as fine sawdust amongst others can cause cancer of the lungs. If you have to remove these and other sources of dust play safe and use a vacuum cleaner, I keep an old one in the workshop permanently but it does have a good leak proof bag.

Blowing swarf around means it can be driven into the eyes or the skin besides being forced under the slides of machine tools or into bearings. Equally bad is the possibility that it may be blown into an electric motor which may look exciting, just like fireworks in fact but the show is rather short lived besides being expensive to clear up afterwards.

On the positive side compressed air is useful for paint spraying (in a well ventilated area or with extractor fan), the same precautions apply to grit blasting, it opens up the realm of pneumatic tools or models as interesting projects too. Compressed air can be used for leak testing of boilers and other containers but do bear in mind that leak testing is quite different to pressure testing. Horrific explosions may result from pressure testing with compressed air just as with steam. Leak testing means pumping up to a few p.s.i. only then immersing the object in water to look for bubbles escaping.

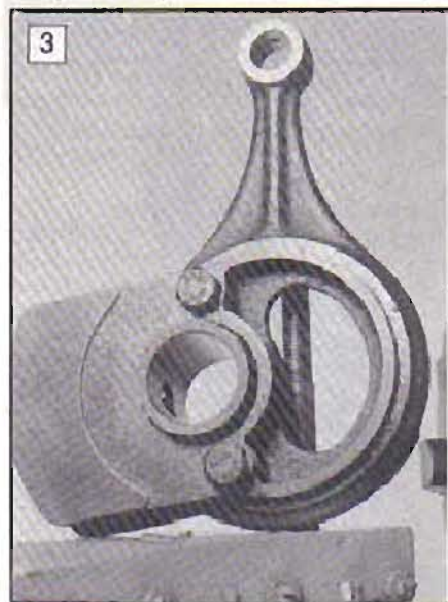
Assuming then that we can justify restoring our newly found treasure let's examine the next step.

Cleaning and external inspection

This part is emphasised as a first step because cases have been known where machinery has been stripped down and new parts made only for it to be discovered that a cracked main casting means it is useless when finally run. I know such castings can be repaired by welding, brazing or cold 'stitching', etc, but can YOU do it? If not it will cost a lot if someone else has to do it for you.

Clean off all grease and dirt with paraffin or Gunk before attempting to dismantle. Do not be tempted to run a neglected machine just to see if it will go. This compressor had been lying under a bench on which a grinder was mounted, over the years grinding dust had covered it in a grimy layer. Where the dipstick was missing it had fallen inside as was afterwards discovered, had it been run considerable damage would have been caused to bearings and bores.

If paint is in poor condition or if heavily



3: The connecting rod and eccentric. Note the bolted on balance weight.

rusted in parts give it a good wire brushing, wipe clean then examine all parts closely for cracks and chips.

Dismantling and internal inspection

Where no serious external damage has been found thought may be given to dismantling. Carry this operation out in a methodical manner keeping each group of parts in a separate cardboard box. It is a great mistake to take everything apart only to mix all the bits up in one heap. Very often different length bolts of the same diameter may become mixed up and replaced in the wrong position with the result that something fouls, it might even cause breakage of irreplaceable components. If not familiar with the machinery make notes as it is taken apart since it might be quite a while before it all goes back together so the sequence is likely to have been forgotten. Tie labels onto parts where needed.

Of course dismantling can be less than straightforward due to seized or corroded nuts and bolts, if so apply penetrating oil leaving it plenty of time to penetrate right through the threads. A second, third, or more applications is often required before the part will unscrew readily. Resist the



4: The flap valve fitted to the crown of the piston.

urge to use brute force leading to stripped threads, broken studs and so on as putting right such damage is far worse than waiting until the oil does its job. In very stubborn cases heat up the end of a half inch diameter steel bar to bright red heat then hold it firmly against the offending nut, bolt, stud, pin, etc. There are few that will resist this treatment, do it several times if need be.

Always make sure you have the correct well fitting spanner, preferably a socket type or ring spanner to avoid damaging the corners of nuts. Be sensible about the amount of force used remembering that the length of a spanner has been designed in proportion to the diameter of thread it is intended to be used on, don't try to increase the leverage by putting a length of pipe over the spanner or breakage is almost inevitable. The use of 'long dismantling spanners and heavy flogging hammers' belongs to the construction industry and agricultural machinery not to precision equipment. Consider using a 'Nut Splitter' if one just cannot be unscrewed as often the thread of the bolt or stud may be undamaged once the nut has been split.

In most cases where for instance studs are broken off short in the hole the proper procedure must be used to remove the fragment, trying to botch it only makes the job longer and more difficult. Industry might use a spark-erosion machine to do the job but we must improvise as well as we can. Often the face concerned has other stud holes which allow a drilling jig to be made with a suitably sized hole to guide a drill equal to the core diameter of the stud or a little less. After drilling out the remains of the stud a taper tap will clear the thread.

Fig. 1.

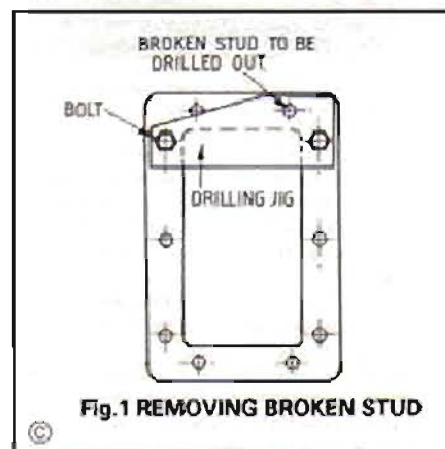


Fig.1 REMOVING BROKEN STUD

Quick Tip

When centre punching stainless steel prior to drilling, if you find that the material has work hardened locally (see article on adapting Frick drills) around the punch dot, as so often is the case, try using a centre punch which has had the point ground in the form of a three sided pyramid instead of conical. This will help to get the drill off to a good start without blunting it.

Alan Jeaves

When removing circlips make sure the proper circlip pliers are used, other means may well get the clip out but most likely at risk of damage to the circlip itself, the groove it rests in and possibly adjacent parts as well to say nothing of the fingers or temper of the operator.

Parallel pins, taper pins and roll pins all need removing properly. In particular make sure the SMALL end of a taper pin is being struck, yes measure both ends FIRST, it has not been unknown for someone to spend hours trying to force one out the wrong way. The excuses as to why it won't shift have to be heard to be believed, and the names they call the poor bloke who put it in ... well! **Fig. 2.**

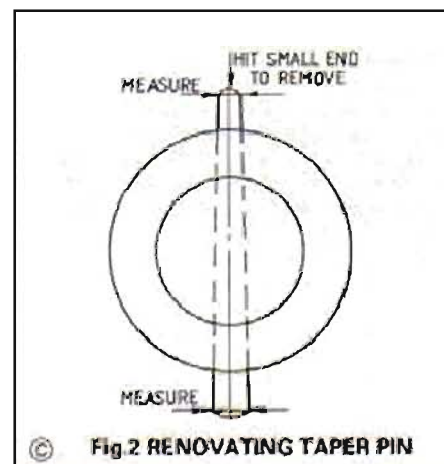


Fig.2 RENOVATING TAPER PIN

Pins should not be struck directly with the hammer, use a proper flat ended punch of appropriate diameter holding it as closely in line with the pin as possible. A few good firm blows are much better than lots of silly little taps but great clumsy thumps are worse than useless.

Once everything has been taken apart each piece must be checked for wear and other damage. In the case of the compressor both the cylinder bores and the pistons were measured. This is a twin cylinder single stage compressor having cast iron bores and pistons. Fortunately the ringless pistons were a very close fit in the bores. Had there been appreciable wear requiring the cylinders to be rebored it would have meant making new pistons, not an impossible task but it was a relief not to have to do so. An alternative would have been to skim the pistons true to fit liners inserted in the bored out cylinders, there was a problem here though in that the bores were very close together as can be seen in one of the photos. **Photo 2.**

I believe that compressors suffer much less wear than for example I.C. engines because only cool air is drawn into the cylinders, it becomes heated by

compression requiring cooling fins around the cylinder to keep the temperature rise within reasonable limits. Provided lubrication is attended to and an efficient air filter provided wear should be minimal over a long period. In an I.C. engine the fuel tends to wash oil off the cylinder walls, temperatures and pressures may be higher as well as the combustion products being of an acidic nature therefore corrosion plus frictional wear can occur.

It will be noticed that the 'crankshaft' of the compressor is in reality an 'eccentric shaft'. The large diameter eccentrics and straps possess a very large bearing area, as they dip into the sump oil at every stroke very little wear would be expected in this area. The shaft bearings being of generous area likewise remained in good condition.

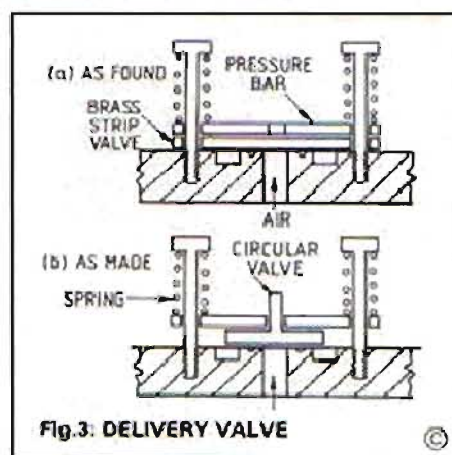
Photo 3.

At this point you may be thinking that there was nothing wrong with the compressor so why am I bothering to write about it. You will see that the pistons have a hole through the head that is covered by a thin springy sheet-metal valve. The valve strip is secured to the head by a single screw besides being located by a pin fixed in the head that passes through a clearance hole in the strip. The bad news is that at some time the screw must have come out of one piston and had been hammered onto the valve seating badly denting it. The seating on the other piston was worn too by the continual clattering of the valve.

Photo 4.

Incidentally where the screw had been trapped the thin valve strip was badly split, an attempt had been made to bodge things by applying an unsightly coating of soft solder over the splits. It is doubtful if the machine ever worked satisfactorily in that state.

When the head was separated into its two parts revealing the non-return valves an equally sad sight was observed. Since only a little oil passes through with the air to this region the years of neglect had taken their toll in the form of rust pitting. Once again the valves had been boded by replacing the original discs with brass strips that were not even flat, no wonder it had been discarded. **Fig. 3.**



The air filter/manifold outlet unit was also a mass of rust internally though the pressure gauge and hose connectors appeared to be in good condition. The tank or air reservoir was rather home-made having been welded up from fairly thick steel tube with dished end pieces. No inlet air filter was fitted, instead the inlet flange carried a lead sheet cover bolted on!



5: The remains of the old gasket were scraped off prior to inspecting the bolting face.

Note and List all repairs and new parts needed

Now I know not everyone does this part of a restoration, they just seem to make the bits in a somewhat haphazard fashion as the fancy takes them. Perhaps they keep a list in their head but it is not the way I can work. I need to write down a list of each operation to be done or part to be made for each sub-assembly as follows:-



6: Using a fine file to remove the burrs from the bolting face.

Crankcase: clean off old gasket faces, scrape or file to remove burrs, tap out and lightly countersink all stud-holes, check faces for flatness, lightly chamfer main bores, thoroughly clean internally and externally.

Check studs and bolts, make new ones as required or re-use, make new gaskets, make dipstick, make inlet air filter.

Shaft: Check all bearing surfaces including eccentrics and straps, check for bent parts, check for cracks.

Pistons: Face off heads only to just clean

up valve faces, grind heads flat and smooth with fine abrasive paper on surface plate, tap out screw hole, check security of valve pin, renew spring washers.

Make new screws if required, make new valve strips.

I won't go on to detail all the other items, I'm sure you'll have the hang of it by now but I will explain each operation as we go along.

There are a number of advantages in working this way, first of all most of us have rather poor memories especially when some time has elapsed since we started the job. Having to break off to do other pressing tasks interferes with our concentration too. Forgetting just one important job until after the machine has been re-assembled can be most irritating. Secondly we may need to purchase, scrounge or otherwise obtain some small but vital parts, this might take some time to accomplish so it is best to ensure that these points are dealt with at an early stage. Some jobs need to be done in a certain sequence, sort that out in your head by all



7: Light countersinking was the method chosen to remove the burrs around the stud holes.

means then write it down as you may not be able to deal with it right away. If at any time you have an unexpected ten minutes or half an hour to spare in the workshop it is a waste of time to sit thinking what to do next when a glance at your list will give an instant idea, this alone can easily save a lot more time than it took to write the list in the first place when things were fresh in your mind.

Operations

By this I mean those tasks that have to be performed on the existing usable parts of the machine before they are fit to be put back into use. It will be noticed that in the list given earlier each bit was in two parts, operations to be performed and new parts to be made. It is usually, though not always, the 'operations' that are best suited to that odd ten minutes or so in the workshop. My photos of the operations on the crankcase/cylinder block unit illustrate this aspect of the work.



8: The stud holes were tapped out to clear accumulated dirt.

Let us take the bolting face around the top of the cylinders for instance, here there are several distinct operations to be performed for which it saves time if a definite sequence is followed namely:-

Scrape off all traces of old gasket using a not too sharp scraper, lightly file with a fine cut long file to remove any burrs taking care to hold the file flat on the surface working from all directions. Lightly countersink all the stud holes and lightly chamfer the top of the cylinder bore using a triangular or half-round scraper. Tap out the stud holes. **Photos 5 to 8a.**

The reasons for these operations are respectively:- to enable the new gasket to seat properly, to remove previous damage from the flange, to remove possible distortion around the stud holes caused by over-tightening in an effort to obtain a seal with unsatisfactory surfaces, to remove corrosion products from the threads that might interfere with the fit of the studs. The reason for doing it in that order is because: it would be silly to clean out the threads first only to fill them up with gasket scrapings afterwards or with countersinking debris.

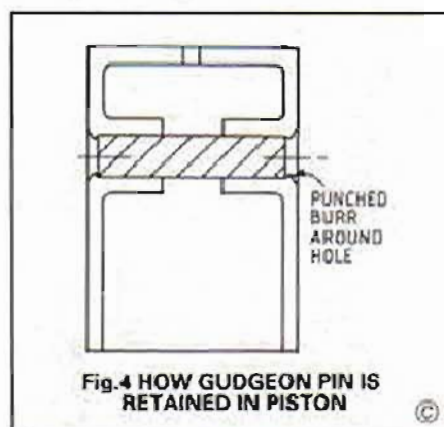
The checking for flatness with straightedge and with small surface plate should be carried out after cleaning off the face and countersinking but before tapping just in case further scraping with a sharp scraper is needed to correct uneven face. **Photo 9.**

Each of the bolting faces of the casting was dealt with in this way before finally giving the whole casting a thorough clean inside and out.

Pistons

I was surprised to find that the gudgeon pin was retained in the piston by the rather crude process of 'rivetting' the lightly chamfered edges of the hole in the cast iron piston. Although crude it had kept the pins in their place. To remove them the side that was least distorted was carefully worked upon with a small triangular scraper to remove the worst of the distortion. The piston was supported in a makeshift wooden Vee block with that side

of the hole downwards whilst a brass punch slightly smaller in diameter than the pin was held on the upper end. A few clouts with a club-hammer drove the pin cleanly out. **Fig. 4.**



The main operation on each piston was to hold it gently in the 4-jaw chuck to face the top sufficiently to just remove the damage from the worst one, the same amount being removed from each to preserve the balance as well as to ensure that they both pumped equally. After facing the pistons were smoothed and polished by rubbing on fine abrasive paper supported on the surface-plate. **Photo 10.**



8a: Scraping a chamfer around the cylinder bore, using a triangular scraper.

The sharp edge left around the top of the piston was given a very small chamfer with a fine file then the thread for the valve securing screw was tapped out to clean it. **Photo 11.**

The pin at the centre was found to be part of a screw inserted from the underside. Its tightness was checked and found to be satisfactory.

Other than cleaning the conrod/eccentric assemblies required no attention so they were reassembled to the pistons at this point. The gudgeon pins showed slight wear over less than half the diameter so the unworn portion was positioned

towards the top of the piston to take the thrust loading. The pins were pressed into the pistons using the vice and wooden Vee block. A flat ended hardened steel punch was employed to 'rivet' the end of the holes again, only a slight effect is sufficient to prevent the pin from moving.

It may not be appreciated that the clearance between piston and head must be an absolute minimum if good pumping efficiency is to be achieved. Any volume of air trapped when the piston is at top dead centre will merely expand again into the cylinder as the piston falls thus lessening the volume of fresh air that is drawn through the piston to refill the cylinder.



9: Using a straightedge to check the bolting face.

Incidentally having a valve in the piston head is an excellent way of cooling the piston with the incoming air. My enforced skimming of the piston head will have reduced the pumping efficiency somewhat which is why the amount removed was kept to the absolute minimum to just clean up the valve face. To show how closely the piston approaches the cylinder head notice

Quick Tip

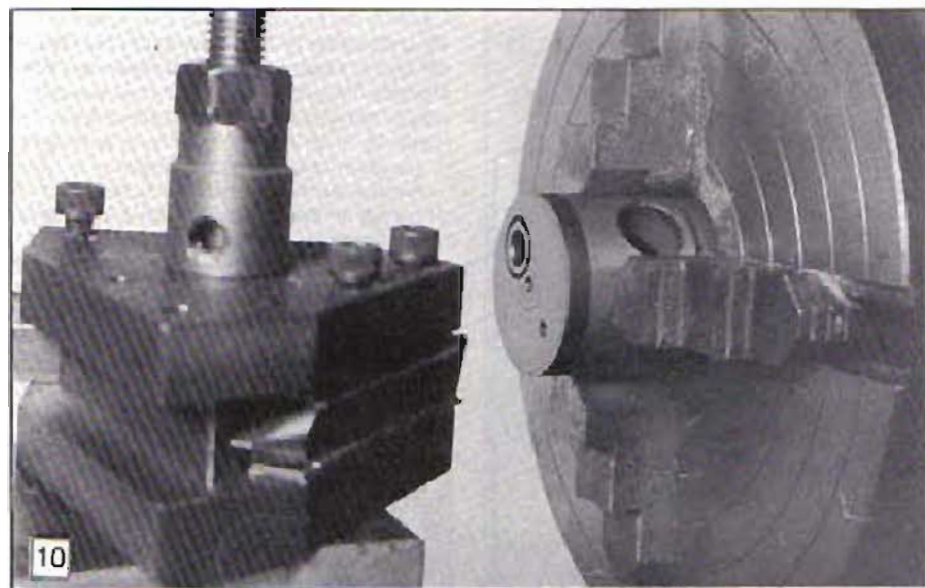
Often, when a component has been roughly cut to size, there will be an awkward amount to come off, just too small to saw but a lot of hard work to file.

A useful method is to reduce the surface area to be filed. This is done by using the corner of a hand or flat file to cut grooves in the work which almost touch the line to be filed to. If the grooves are cut diagonally and crossed by another set at 90 degrees, it will make the job even easier.

Because the grooves have reduced the surface to be filed it is much less hard work and when the grooves have been completely cut down and disappeared, the final clean up should be no trouble.

Flat or hand files don't have to be used for making the grooves; square, three-square or the edge of a half-round would do just as well.

R.J. Loader



10: Lightly facing the head of the piston in order to clean up the valve seat.

on the photo how the head is drilled to accommodate the valve securing screwhead. Putting the head on the wrong way around could prove disastrous. **Photo 12.** Notice also on this side of the head the corrosion pits adjacent to the edge of the bore. These were deemed not to necessitate refacing the head which would mean surface grinding to do a good job of it. Similarly the light corrosion on the upper or valve side of the head was insufficient to warrant refacing also because the circular valve faces themselves were in good condition, this was probably due to oil trapped in the small inner groove under the valves. **Photo 13.**

The operations on the head therefore consisted only of cleaning off old gasket material, twiddling a countersink cutter in



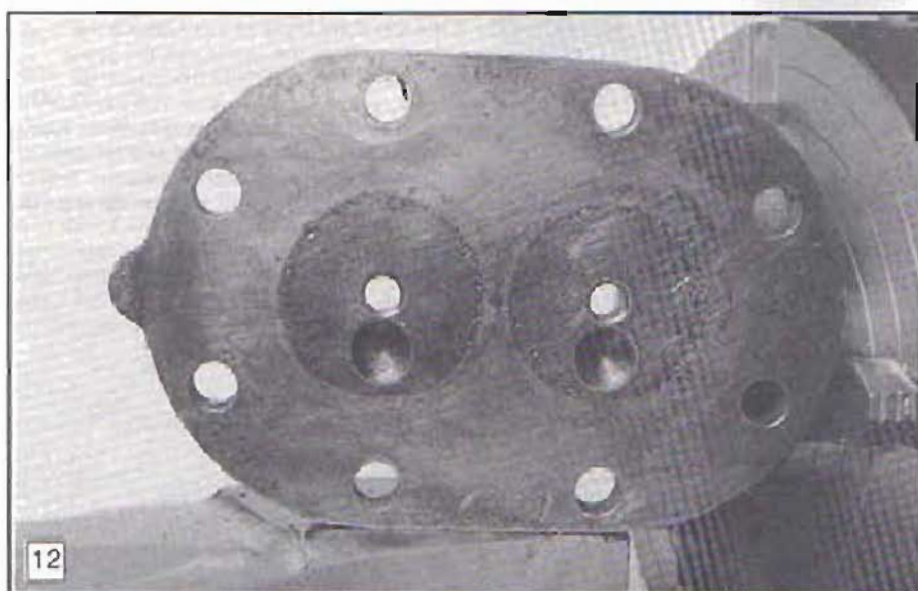
11: Final polishing of the head of the piston, using abrasive paper on the surface plate.

each end of the stud holes, rubbing flat on fine abrasive paper on the surface plate and tapping out the valve spring securing bolt holes. The upper or air-receiver portion of the head was similarly treated on the bolting face and thoroughly cleaned of internal rust deposits including the cast-in channel leading to the three way tap bolted to the outlet flange. **Photo 14.**

This tap was likewise cleaned internally and externally, as was the delivery filter/manifold. The pressure gauge was dismantled, cleaned, oiled and reassembled.

holes to be dealt with. After loosely inserting all the studs the inner edge of the casting is followed all around with the hammer until the central part of the sheet falls out. Finally the same treatment is given to the outside edge of the casting and the result is a neatly fitting tailor made gasket. Hang each one up in a safe place until required for reassembly.

The valves fitted to the piston tops were tackled next. The original ones consisted of thin springy steel strip around ten thou. thick, although no steel was to hand I did have some ten thou. phosphor bronze sheet so that was used instead. The old one was used as a template to scribe around before cutting to shape with tinsnips. The two hole positions were also scribed through, centre-punched and drilled. The method of fixing the valve to the piston was rather interesting in that a small spring washer of the 'internal star' type sat inside a clearance hole in the strip, the head of the screw being larger than the washer prevented the strip from rising up



12: The piston side of the cylinder head, showing the recess to clear the valve screw on piston crown.

Making new parts

The first job was to prepare a complete new set of gaskets similar to the original which were of thin jointing material like Hallite. It is best to do this before the studs are refitted because the sheet of material can then be placed onto the bolting face whilst the rounded end of a ball-pein hammer is lightly tapped into one stud hole neatly cutting out a disc of the exact size.

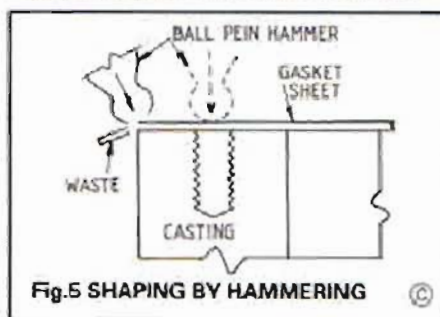
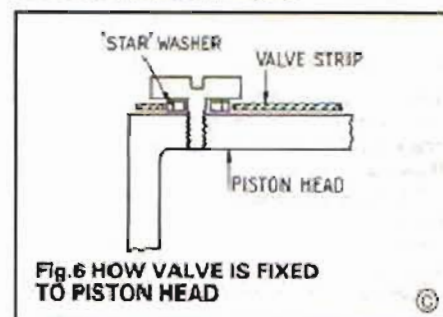
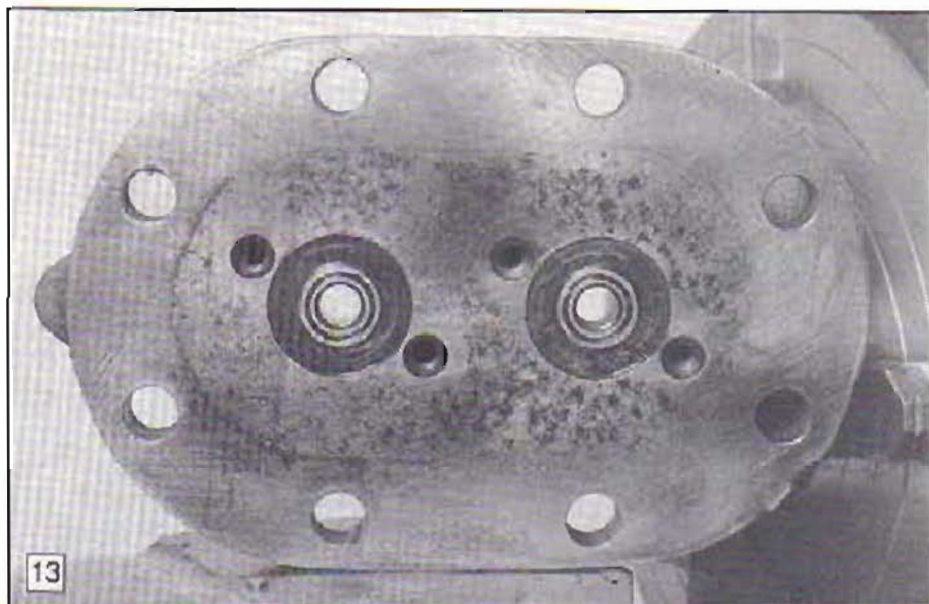


Fig. 5. That stud is temporarily fitted to locate the material so that the opposite hole may be hammered upon allowing a second stud to be inserted. These two will hold the sheet in position for the other stud

at that end. Since the strip was slightly thinner than the washer it had a certain amount of freedom though very limited, the pin at the centre prevented any sideways movement yet still allowed the strip to flex vertically. **Fig. 6.**



The outlet valves in the head were in a very sorry state with support bolts, springs and crossbar very rusty. As previously mentioned the original valves themselves had been replaced at some time by 1/8 inch thick brass strips having a hole at each end to fit the spring support bolts. A hole at the centre of the steel crossbar suggested that a different form of valve had been intended by the designer thus necessitating a little



13: The cylinder head showing the delivery valve seats. The file scratches are NOT the author's, they are remnants from a previous "repairer".

thought as to what form it might have had.

Seeing that the valve seating was surrounded by a fairly wide shallow groove it was decided that a circular valve would be the best solution, the hole in the crossbar must have been provided to guide the stem of the valve anyway. It was a relatively quick job to turn two valves from a length of $\frac{1}{8}$ inch diameter brass rod, it might be thought that brass is a little soft for this application but in view of the limited intermittent use envisaged it should be adequate. For prolonged operation stainless steel would be the preference because the inevitable condensation of moisture from the air passing through might lead to further corrosion despite the oil mist also entrained, the additional hardness of stainless steel would ensure longer life too. **Photo 15.**

After cleaning off all the rust it was decided that the rest of the valve assembly could be re-used including the springs. A small problem was the fact that the security wires through the bolt heads had been broken off leaving the holes blocked, the pieces could not be punched out. The sides of the heads were filed to form flats enabling the holes to be drilled through. The constant vibration of the valves tends to loosen fixings which is why they were wired in the first place, if a valve does come adrift it is not so serious here as with the ones on the pistons but it is best avoided if possible. A loop of stainless steel wire through each pair of bolts does the needful.

Having been robbed of its driving pulley it was necessary to find a 'new' one, BUY one did you say? Not if I can help it! A search through the model engineer's treasure chest (scrap box it is called by the unkind) turned up an old washing machine pulley ready for re-cycling. As would be expected it did not fit the compressor shaft but that is a job easily remedied. The boss was bored out and fitted with a steel bush taper bored to match the spindle taper, Araldite secured the bush into the pulley. **Fig. 7.**

The remaining item made was the oil level dipstick which was made from $\frac{1}{8}$ inch dia. at the upper end where it fitted the boss in the casting, a ball head was turned

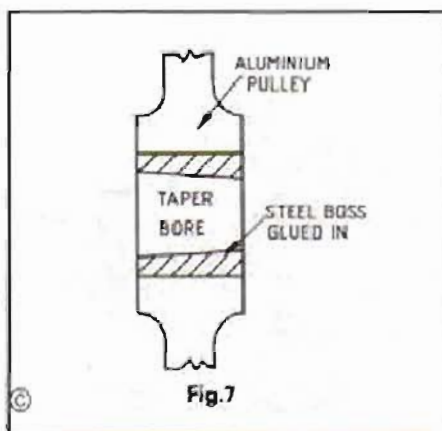


Fig. 7



14: The cylinder head being polished on the surface plate.

on the end to grip. The lower part was of $\frac{1}{8}$ inch dia. steel Loctited into the upper part. The length was adjusted until just clear of the bottom of the sump then a $\frac{1}{8}$ inch long portion of the end was filed to leave a flat on which the level could be seen. **Fig. 8.**

Assembly

Having noted the amount of rust inside parts of the compressor when it was dismantled it was thought to be wise to wipe a coating of pump oil over all internal

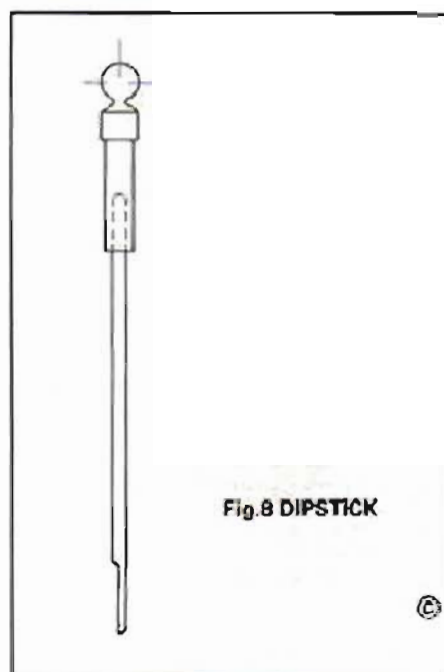


Fig. 8 DIPSTICK

surfaces. A coat of oil resistant paint would probably be better but that would necessitate thorough grit blasting of the surfaces as a first step, an alternative might be to treat it all with one of the proprietary rust treatments now available. **Photo 16.**

All moving parts were likewise oiled before refitting. Incidentally it horrifies me to see people 'repairing' car engines and other machinery who do not bother to clean off all the old dirt and sludge before reassembly, they don't even clean the bench or wash their hands. I prefer to see the bench covered with clean newspaper and all the bits in clean cardboard boxes – the latter don't cost anything, supermarkets are only too glad to get rid of them.

helps to prevent the gasket from sticking to the faces so that future dismantling is much easier and secondly it allows the gasket to spread slightly as tightening proceeds thus giving a close, even, fit.

Modern 'liquid gasket' materials are fine if the machine is designed for them, since they require very closely fitting surfaces to give virtual metal-to-metal contact over the whole joint area it means clearance might be affected. In this compressor for instance the joint between head and cylinder is designed to give minimum clearance with a gasket fitted. If no gasket were fitted and one used 'liquid gasket' to provide a seal instead it is possible that the piston might foul the head. One needs to be alert to these dangers at all times.

Before bolting on the cylinder head with delivery valves fitted the screws holding the inlet valves to the piston tops were given a final check for tightness. That does not mean giving the screws an extra turn 'just to make sure', all that makes sure of is that the threads are strained and it is likely to fracture. Just reasonable force for the size of screw should be the aim and that is



15: The cylinder head with delivery fitted and wired.

unfortunately something that can only be learned by experience, the sadder the experience the more forcibly is the lesson learnt.

With the compressor assembled the pulley was tapped onto the taper and given a few turns by hand with the thumb over the outlet, it was satisfying to hear the rush of air as the thumb was released. It will be realised that with the type of self-acting valves fitted this compressor will run happily in either direction therefore rigging up a drive becomes less of a problem.

Attention was now turned to the manifold unit which consists of a short length of steel pipe with a cast iron socket at each end, a long bolt passes upwards from the base to screw into a socket inside the head below the pressure gauge. Again gaskets were made for the tube to seat on at each end and a fibre washer was fitted under the head of the bolt.

This unit acts as an oil separator and outlet filter as well as having the outlet connections, gauge and a safety valve fitted. The filter was missing so a new one was made from fine wire mesh in the form of a cylinder, it was lined with a layer of coarse wire wool to trap the oil mist that might get this far, a pad of cotton gauze at the top sandwiched between two discs of mesh completed the filter. The bolt passed up through the filter. Fig. 9.

It was necessary to re-cut the safety valve seating using a 'D' bit before the

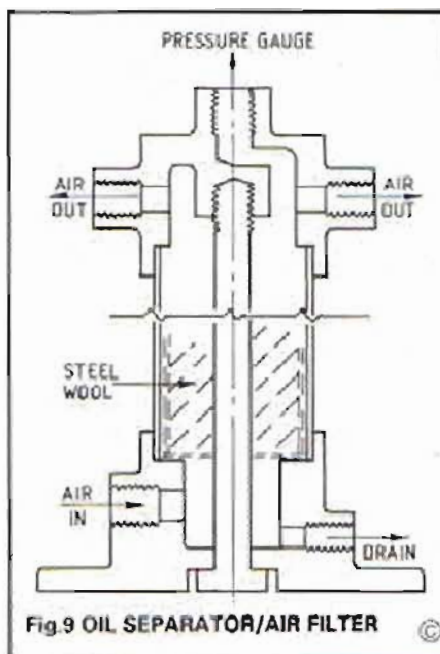


Fig.9 OIL SEPARATOR/AIR FILTER

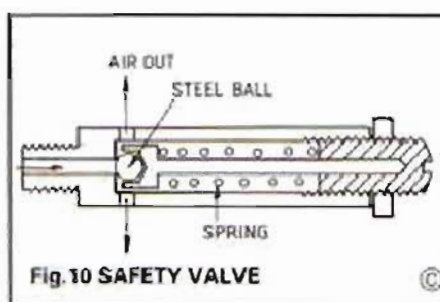


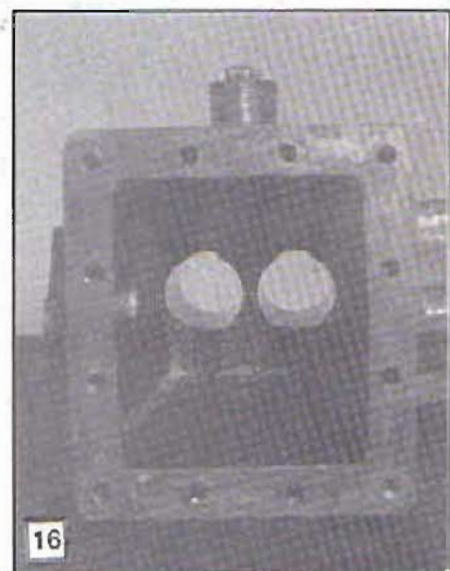
Fig.10 SAFETY VALVE

spring loaded ball would seal properly. Fig. 10.

A close examination of the welded steel tank showed it to be quite sound, a few taps with a ball peen hammer revealed no thin areas. In view of the relatively small diameter coupled with the thickness of the walls it was considered fit for use up to 100 psi without the need for a pressure test ... it would probably stand 1000 psi by the look of it. This does not mean that I am careless about safety but have here relied on experience as being a good guide. I would most strongly advise anyone without such experience to conduct a proper hydraulic pressure test on every pressure vessel made before putting it into use. In this case the tank will probably mostly be used at around 30 psi. It is intended to replace it as soon as possible with an ex-lorry air brake tank of larger capacity.

Piping arrangements merely needed

some joints to be re-made before connecting up. Air from the compressor passes through the 3 way valve attached to the head which either vents to atmosphere or directs the air into the tank. Another pipe from the tank leads to the manifold which has two standard airline quick release connectors with internal shut off valve that seals the system as soon as the hose is removed.



16: The interior of the crankcase.

Motorising

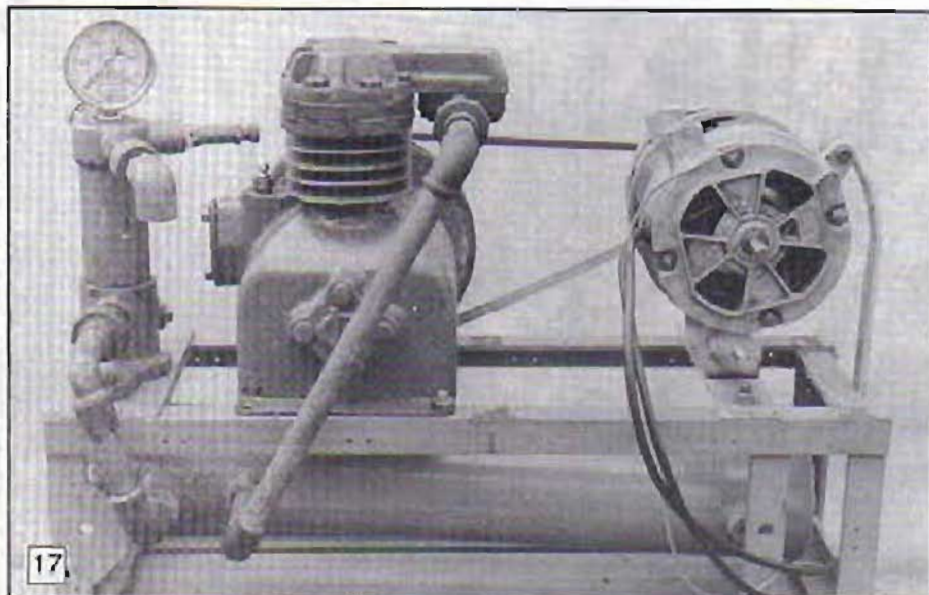
Once again the recycled washing machine contents came to the rescue, what would we do without them?, in the form of a 1/4 H.P. electric motor. The long mounting lugs were sawn off leaving the stub ends remaining to be drilled for a pivot rod of 1/8" steel. A bracket bent from 1/2 inch thick steel strip fitting outside the lugs was also drilled 1/8" dia. for the rod to pass through. Photo 17.

A Vee belt from the treasure chest decided where the motor pivot bracket should be bolted to the framework. The belt was tensioned using a strip of metal that hooked over a bolt through another lug on the motor, this strip was drilled near the other and with a number of closely spaced holes (easier than making a slot) in one of which a bolt was placed to attach it to the framework.

Testing

Temporarily wired up the machine was switched on after checking oil level in the compressor. It ran smoothly with the 3-way valve to atmosphere and a good flow of air hissing out. The valve was closed diverting the air into the tank when the gauge slowly began to register, at 30 psi the motor was switched off but instead of holding the pressure the needle slowly but surely fell back.

Pipe connections were checked and given additional tightening prior to switching on again. Once more it failed to hold the pressure so some thought was given to possible sources of leakage, could the air be passing back through the compressor valves? Unlikely with newly faced seats and new valves. An ear to the air inlet failed to detect any hissing there. The cylinder head bolts were given another check in case the gasket had settled under the pressure, that made no difference



17: The piping side of the air compressor

either. The safety valve was not leaking so what could it be?

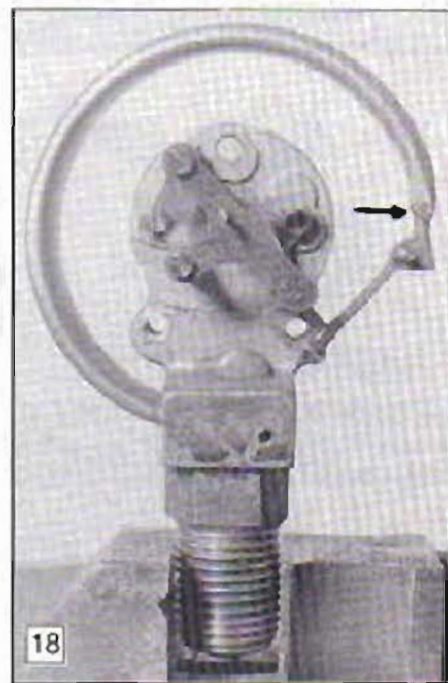
Soapy water was brushed onto each pipe joint in turn, then onto the joints of the manifold. Whilst checking around the pressure gauge a very slight draught was felt but no bubbles appeared where the gauge screwed into the casting. The leak had to be in the pressure gauge itself. Leaving it screwed in place the glass, dial and casing were removed, the hand replaced and the motor started once more.

Soapy water was brushed around the area where the Bourdon tube was soldered

into the block but again no bubbles were seen. Was the tube split? No it was not but there was a leak where the lug was soldered into the free end of the tube. It just goes to show that you cannot take anything for granted in this game. A few minutes work scraping the area clean enabled a spot of resin cored solder to be melted onto the joint using a needle flame propane torch. When reassembled and tested the pressure was finally held. It was found that the motor struggled to get it up to 100 psi therefore the safety valve was set to blow at 30 psi which is adequate for

immediate purposes. A half H.P. motor is available if sustained running at 100 psi should be needed. **Photo 18.**

I really must find time to make that inlet air filter and wire the motor to a switch, still it does work very well considering the state it was in and it cost only a little time and effort ... one of life's rare bargains you may think



18: The interior of the pressure gauge, the arrow shows the position of the leak mentioned in the test



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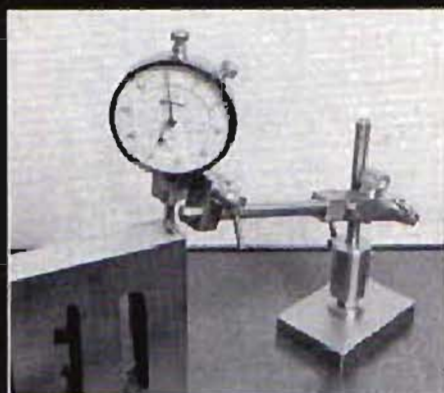
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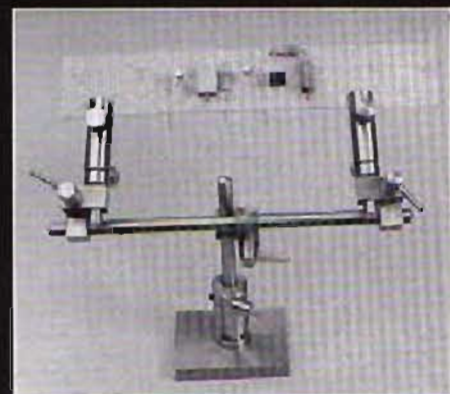
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TAPPING SQUARE

In this mini article Geoff Gray offers a suggestion for a simple device to aid hand tapping

I read with great interest Mr Hayne's article in the February/March '92 issue of MEW about his modifications to his new drilling machine to enable it to be used for tapping holes, thus keeping the tap square. I have tried this method myself and found it lacking in sensitivity, particularly for 1/2in dia. and smaller.

Quick Tip

For beginners: Does your hacksaw wander off course? Then don't press so hard, let the saw do the work!

Similarly, when drilling in the lathe, does the drill start to wobble even though you used a centre drill? No two cutting edges can ever be the same and putting on too much pressure will make one side cut more than the other.

After you've centre popped and started drilling does the drill chase all round the hole? This is because the punch has thrown up a ridge. I used a fine, flat needle file which has some degree of bend and dress off this crater. The drill goes in first time.

Mr C.M. MacE.



The finished jig

The tapping jig, for want of a better name, that I use has been with me so long I cannot remember where the idea came from. It consists of a 25mm length of 35mm dia. BMS faced off square each end with one end recessed about 20mm dia. x 3mm deep. It is drilled down its length, within the recessed area, 2, 3 & 4 BA clear plus No. 30 drill which caters for 5 BA and smaller taps. The holes are also well countersunk at the opposite end to the recess. The larger taps are guided by the

threaded portion when in the jig and the smaller by their 1/2in dia. shank.

The jig is placed over the hole to be tapped, recessed end down, the recess taking care of the metal raised when the tap starts cutting thereby preventing the jig from being lifted. Small taps such as 10 BA are easily broken by careless application of too much side pressure. This jig helps to prevent this provided it is kept in contact with the job. When the job is smaller than the recess, use the countersunk end. Small work can be clamped in one hand, together with the jig, and it's great not having to look to see if the tap is square.

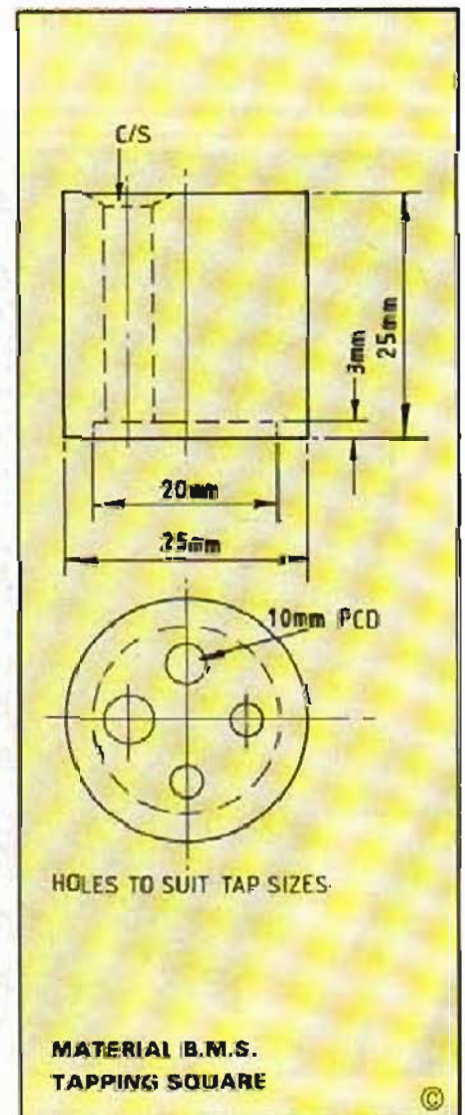
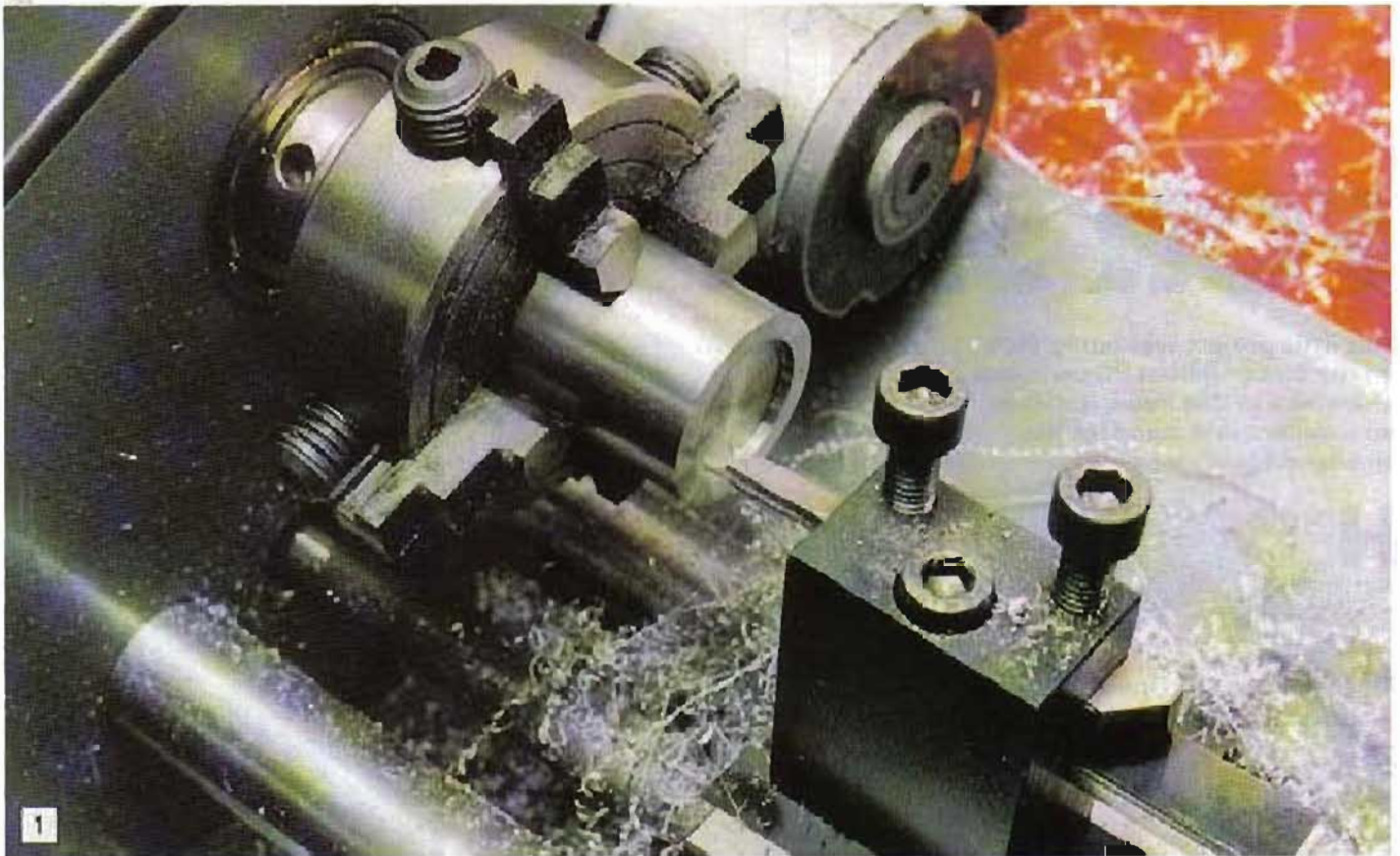
Jigs of a suitable size can be made for metric and Imperial taps.

This jig is only suitable for taps of 1/2in and smaller as I find anything over 1/2in requires both hands on the tap wrench although this will depend on how strong you are. It would be suitable for larger taps if it could be clamped in position but this is not always possible.

Photo 1: Turning the recess on the Universal PC.

Photo 2: With the jig set over in the four jaw chuck, drilling for the smallest tap.

Photo 3: Drilling for the largest tap in a similar manner



DRILL STAND FOR SMALL DRILLS

This little project was completed on the Emco Unimat PC reviewed elsewhere in this issue; it makes an excellent drill stand for the smaller drills.

Having for some time stored my small drills (1 to 3mm) in a box, with the necessity of measuring these with a micrometer each time one was required, it was decided that a simple drill stand should be made.

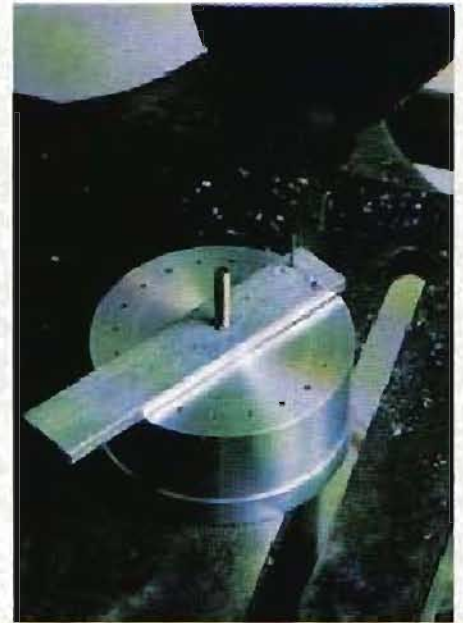
Machining on the Unimat PC

Machining the block for the stand on the small Unimat PC lathe, it would not be possible to part off the block from a longer piece of material placed in the chuck. In view of this a piece of bar was cut to just over the required length using a hack saw.

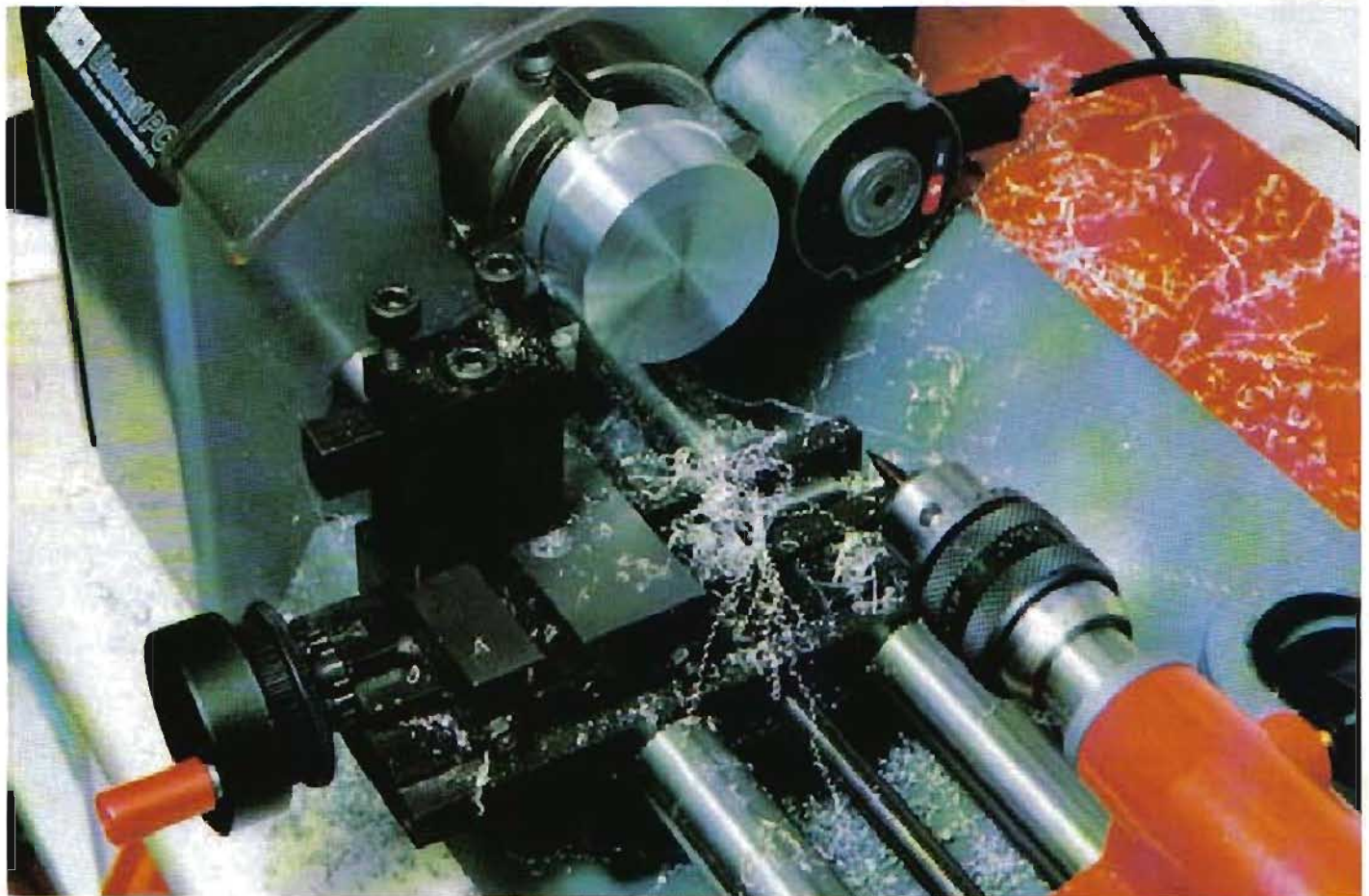
As it would be required to hold the piece in the chuck for machining, it would not be possible to machine the outer diameter at one go. To avoid the need for accurate re-chucking after machining half the length, it was decided to make the outer diameter



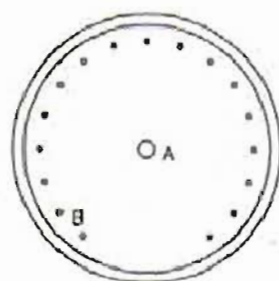
The drill stand with a single row of drills.



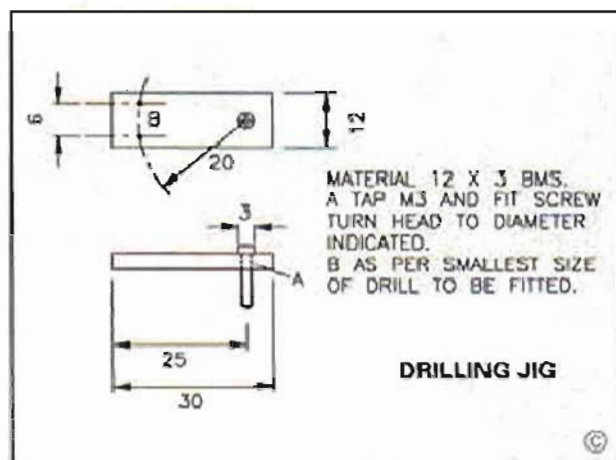
The base being turned on the Unimat PC lathe.



Drilling the holes using the simple drilling jig.



MATERIAL 2"/50mm dia BMS/ALUMINIUM.
HOLES.
A 3mm dia 5mm DEEP.
B INITIALLY DRILL ALL AS PER SMALLEST
DRILL SIZE 3mm DEEP, OPEN UP TO SUIT
REQUIRED RANGE OF DRILLS.
DRILL HOLES USING DRILLING JIG AS
INDICATED IN TEXT.
ALL DIMENSIONS IN MILLIMETRES



stepped. This would camouflage any error in concentricity between the ends, and so avoid the need for accuracy.

Face the ends at the same stage as machining the outer surface, also drill the 3mm hole in the centre of the smaller diameter end. The purpose of this is to locate the drilling jig when making the ring of holes for the drills.

Using a drilling jig

Take a short length of bright mild steel, 3 x 12mm or other suitable size, and drill and tap as per the drawing. Fit an M3 screw in the tapped hole and tighten. Hold the threaded end in the three jaw chuck and turn the head of the screw to 3mm diameter, this to locate in the central hole in the block.

Now choose the smallest drill to be fitted and also a short piece of wire just a little smaller in diameter than this. Locate the turned head of the screw in the central hole and drill the first hole for the drill positions. With this hole drilled, place the piece of wire through the jig and into the hole in the block, then drill the second hole through the other hole in the jig. Continue in this manner until all holes have been made. Choose the range of drills to be stored and proceed to open up the holes to a depth of about 10mm.

Marking the drill sizes

With the holes completed, take a strip of self-adhesive white paper 13mm wide and 160mm long and place this around the block. Mark this with the size of drill to be

stored in each position.

By leaving say two holes still at the smallest size at the small drill end, this will permit additional drills to be added if required at a later stage. This can be done by adding the new drill in the appropriate position and re-drilling for the remainder one hole towards the smaller size.

Expanding its capacity

By adding another hole in the drilling jig on its centre line and about 10mm towards the centre, a second row of drills could be added. These would have to be the larger drills, and therefore longer, to make removal easy. Being closer to the centre they would also be closer to each other, therefore locating a drill in every other position would probably be best.

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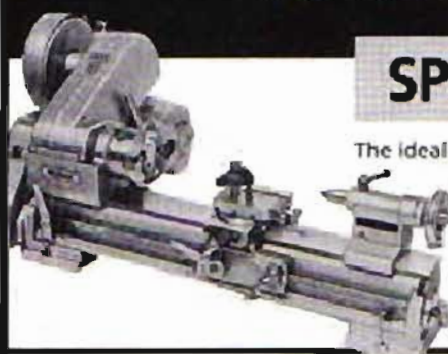
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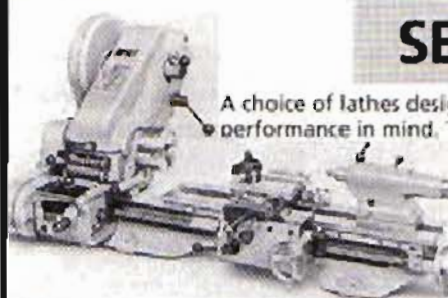
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(G1) 1/2" dia. x 1/2" x 1/2" x 1/2" x 1/2" x 1/2"	1.50 Kilo £6.60
(G2) 1/2" dia. x 1/2" x 1/2" x 1/2" x 1/2" x 1/2"	4.00 Kilo £17.82

BRASS ANGLE

(H1) 1/2" x 1/2" x 1/2" x 1/2" x 1/2" x 1/2"	0.60 Kilo £5.95
(H2) 1/2" x 1/2" x 1/2" x 1/2" x 1/2" x 1/2"	1.50 Kilo £10.88

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(I1) 12mm x 12mm x 3mm x 20mm x 20mm x 3mm	2.00 Kilo £9.08
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(K1) 1/2" dia. x 1/2" x 1/2" x 1/2" x 1/2" x 1/2"	0.60 Kilo £6.85
(K2) 1/2" dia. x 1/2" x 1/2" x 1/2" x 1/2" x 1/2"	3.00 Kilo £16.37

BA STAINLESS STEEL HEXAGON 303

(L1) 152-88A 183-88A 220-88A	1.50 Kilo £10.85
245-88A 281-88A 324-88A	2.50 Kilo £17.46

BA BRASS HEXAGON

(M1) 152-88A 172-78A 193-68A	2.50 Kilo £7.46
220-58A 248-48A 281-38A	3.24-28A

BA STEEL HEXAGON

(M2) 152-88A 172-78A 193-68A	2.50 Kilo £3.37
220-58A 248-48A 281-38A	3.24-28A

BRASS FLATS

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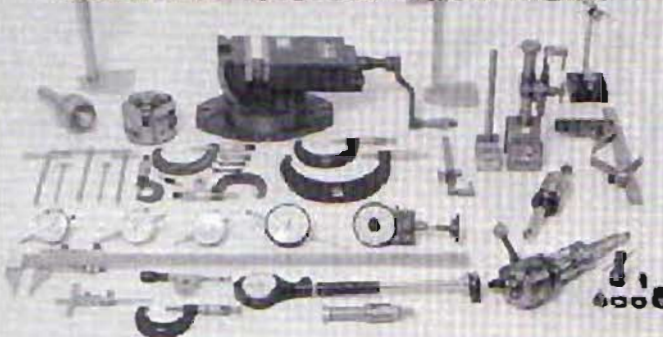
(Q1) 1/2" dia. x 1/2" x 1/2" x 1/2" x 1/2" x 1/2"	0.50 Kilo £6.80
(Q2) 1/2" dia. x 1/2" x 1/2" x 1/2" x 1/2" x 1/2"	1.25 Kilo £17.42

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FIVE QUICKIES

Mr Langam of Stanstead Abbots is one of the 2% of MEW readers in the under 30 age group (as per our last reader survey - 23 years in his case). He has worked as an engine fitter in formula one motor racing — which is evident from this excellent group of mini items he has provided

Hex Tee bar for use with fourway toolpost



Method

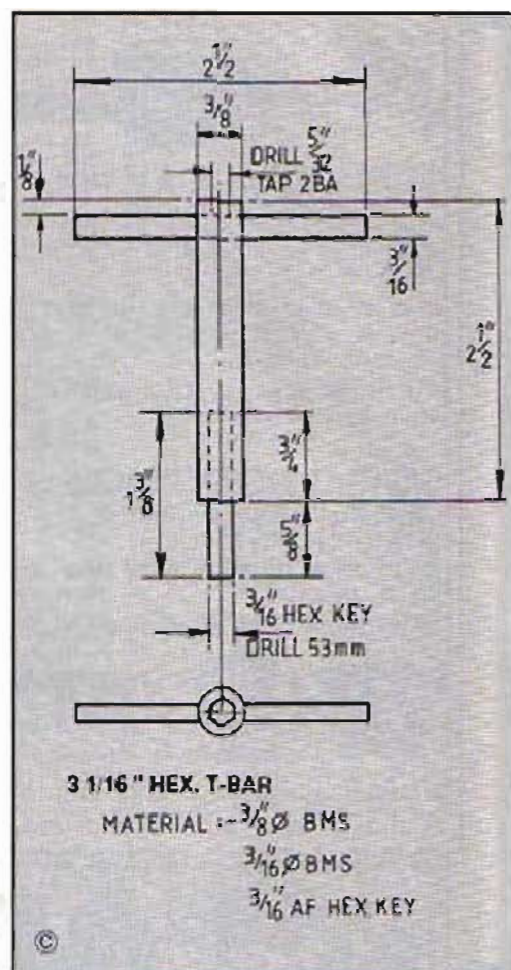
Chuck body material in lathe, face ends and remove. Crossdrill for Tee handle, rechunk, drill tee handle end for grub screw and tap 2BA. Turn around, drill for hex bit, measure hex across corners. Cut the hex key to length, try in body — a slide fit is required. Silver solder in place.

Note! I prefer to use good quality keys such as Unbrako because some poor quality keys go soft after soldering. Finally, face the ends of the tee bar chamfer or round as required.

Fix in place with grub screw.

This tool can be made even better with the addition of some $\frac{1}{2}$ in. i.d. rubber tubing slid over the handles.

These Tee bars can be made in different lengths and hex sizes, and are most useful. Tee bars are commercially available but tend to be rather long.

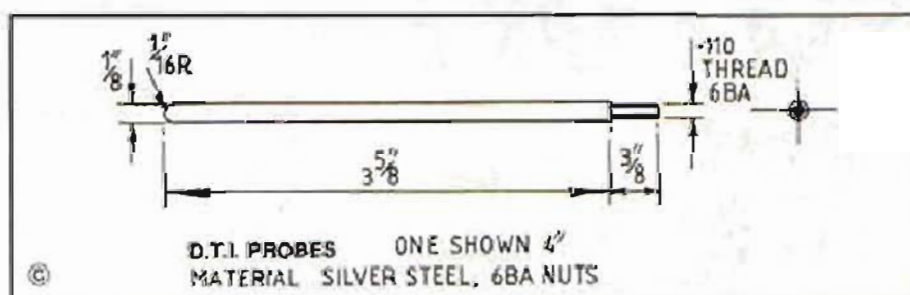


Dial Test Indicator probes

A range of different length probes is useful for a DTI, although not as ingenious as the angled arm in MEW Summer '90. Mine are made from $\frac{1}{2}$ in. silver steel with a 6BA thread $\frac{1}{2}$ in. long on one end and a radius on the other.

Method

I put a large chamfer 45 degrees on one end, roughed in the radius with a bench grinder and then finished off in the lathe with emery leaving a nicely polished



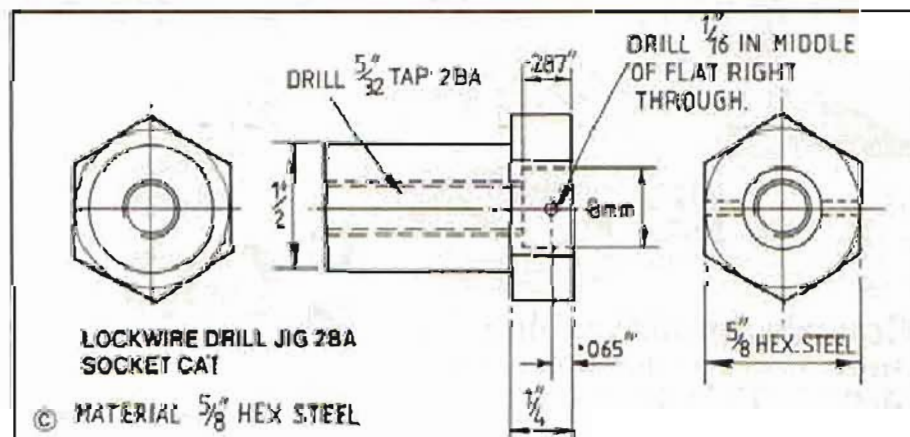
radius. Then I threaded the other end. The only thing left is to screw a 6BA nut on the thread for locking.

NOTE! some dial test indicators such as Draper, have metric threads 3mm by .5mm. Finished lengths: 0 1/4, 2, 3, 4, 5, 6 1/2 inches.

Lockwire drilling jigs

Sometimes on machinery it is necessary to lockwire bolts. Hex head bolts are quite easily drilled. Socket cap head screws can be a problem, if a number have to be drilled, because of the diameter of the drill bit used (around $\frac{1}{4}$ in diameter — they break easily). Also the round head of the screw does not help, and the heads tend to be very hard.

This method is not used much these days as thread locking compounds such as Loctite are very reliable. But it is good visual security...

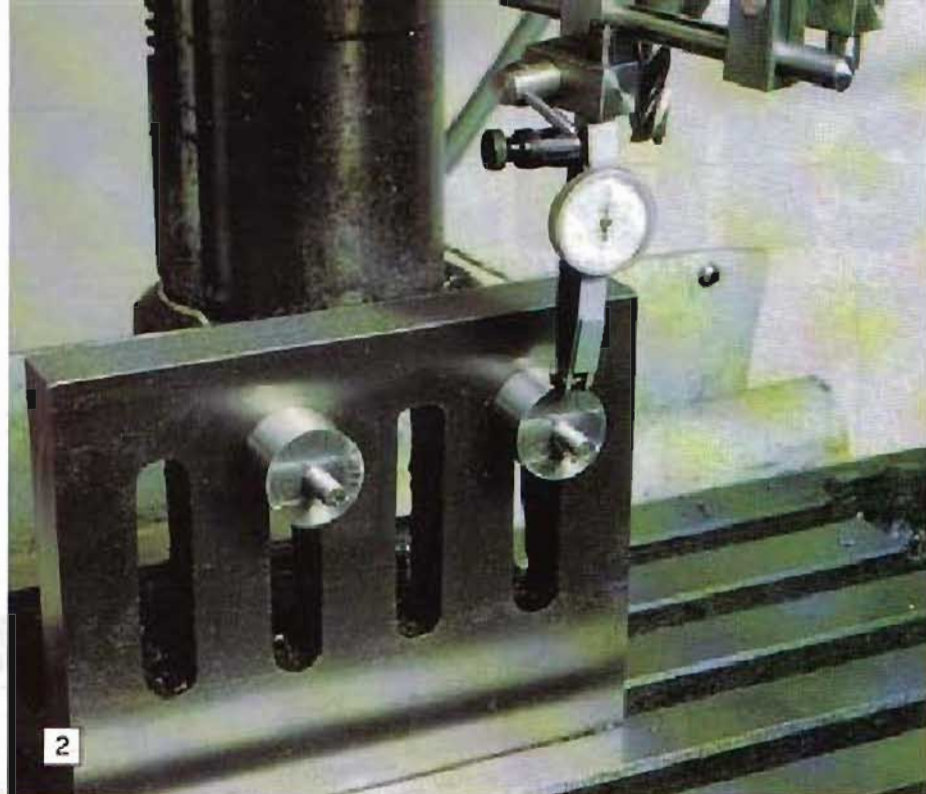


Any reader who has worked in a precision manufacturing or inspection environment will understand the satisfaction of using high quality precision equipment.

In the home workshop such precision equipment will probably be limited to micrometers and a vernier, maybe also a height gauge. Such things as slip gauges, sine bars and precision parallels are likely to be found only in a very few home workshops. In any case, slip gauges and sine bars are more likely to be of novelty rather than any real practical value for the majority of readers. This will be particularly so when considering their very high price...

A set of parallels is, however, a worthwhile addition to any home workshop and worth considering. But at around £80.00 for a set of four pairs and £130.00 for a set of nine pairs, as listed in one supplier's catalogue, they are still a very expensive item.

Whilst very beneficial, as purchased, they are likely to be more accurate than required for all but the most demanding projects. As a result, for most people, the



PARALLELS

A set of precision parallels is a useful addition to any home workshop. However, they are very expensive and probably more precise than required — at least for the majority of applications. So why not make parallels as suggested in this article? They will be precise enough for almost all applications, and will avoid that frantic panic into the scrap box when wanting to make progress with an interesting project!



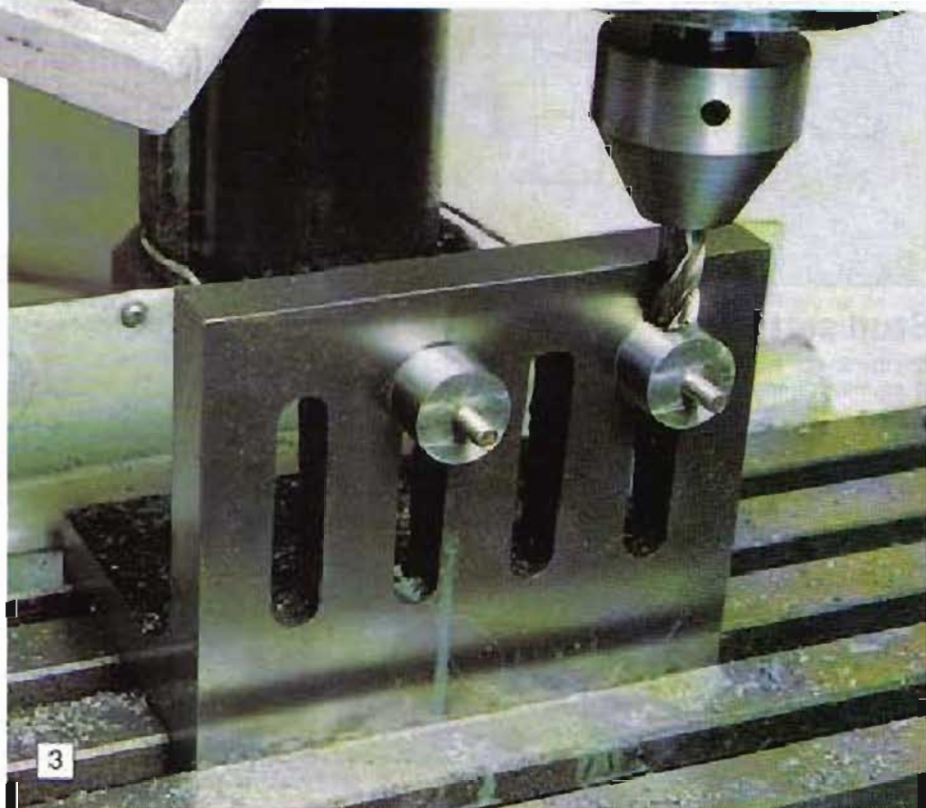
expense will not be justifiable. Where the level of accuracy required is not that demanding, it is probable that most will attempt to make do with pieces of mild steel bar taken from the scrap box.

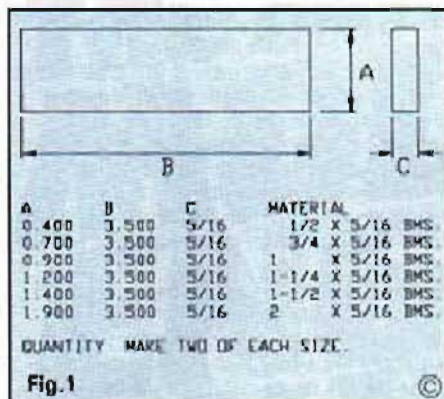
With a well stocked scrap box this may not present much of a problem, but a set of simple home-made parallels in a range of sizes will be much more convenient. Their immediate availability will avoid the need to make do with odd scraps of bar in various sizes.

This is not to say that a home-made set, as shown in **photograph 1**, will in any way match the precision of those purchased. They will, though, be totally adequate for the majority of applications if made with care.

The essential requirements of a pair of parallels is that they have parallel faces and are both the same width, to as close a tolerance as is achievable. A tolerance of better than plus and minus two tenths of a thou. is a good level to aim for.

Of less importance but worth aiming for is the actual width itself. This can be any dimension, but will be easier to work with if made to some rounded dimension, particularly for measuring and marking out work on the surface plate.





The sizes

Those made in this article are 0.4, 0.7, 0.9, 1.2, 1.4 and 1.9 inches. These dimensions were chosen as they required less machining than if making, say, a 0.5 inch parallel from 3/4 inch material, and similar for the larger sizes.

Having chosen the height of the parallels the question of width has to be considered. The width was 3/8 in. which was considered adequate for most applications and would help to keep the cost down. If this width is considered rather narrow it could, of course, be increased if preferred — if not for all, at least for the wider parallels.

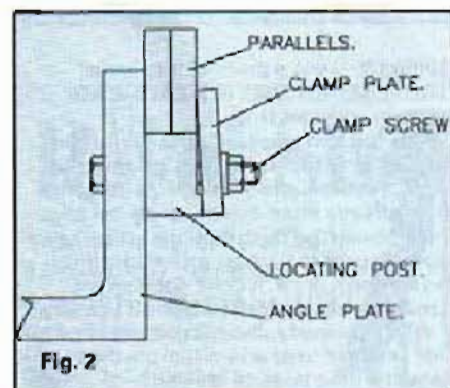
One place where the parallels are likely to be used is the machine vice, therefore the length should at least be equal to the width of the jaws. In this case the vice available is relatively narrow and a longer length of 3 1/2 in. has been chosen. The dimensions are fully detailed in **fig 1**.

Manufacture

Having chosen the sizes to be made, cut off the required pieces a little over length to allow for machining. To achieve parallel faces — which is the most important factor — some method of ensuring this must be established. Unless the machine vice available is very accurate, and similarly the parallels which will be required to pack up to the smaller sizes, some more accurate approach will be necessary.

Edge machining fixture

It was decided to adopt a method of locating the parallels on two posts mounted on the face of an angle plate, adjusting these such that they were both at the same level. The method, as envisaged, was to mount the two posts onto the angle plate, then using the slots adjust the height of each such that they were both at exactly the same height. This can be seen in **photograph 2**.

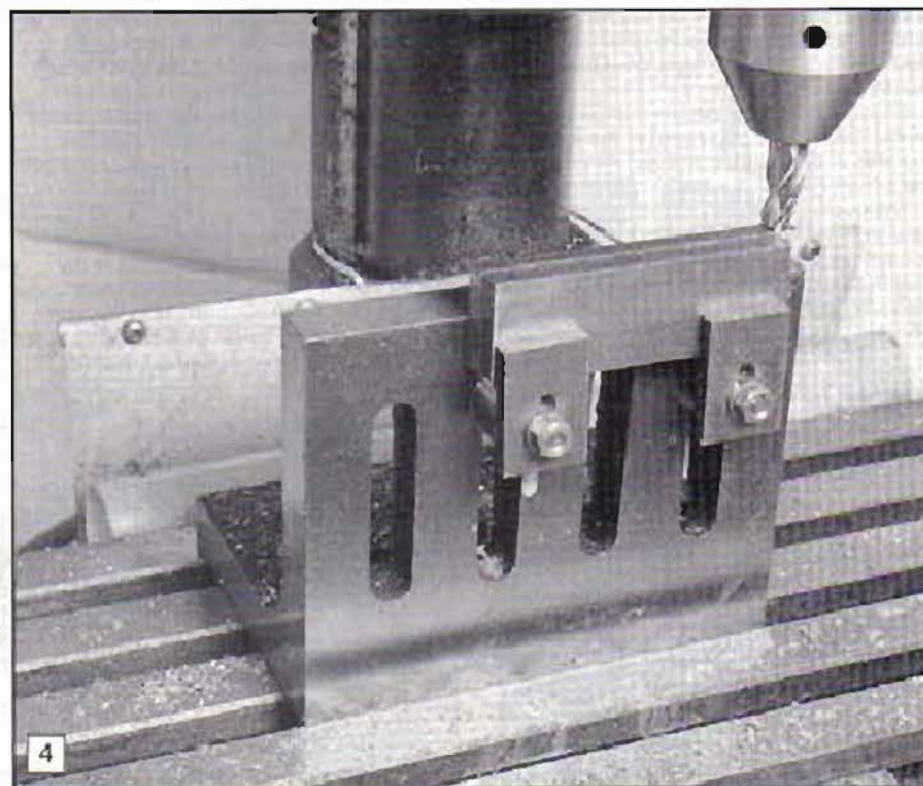
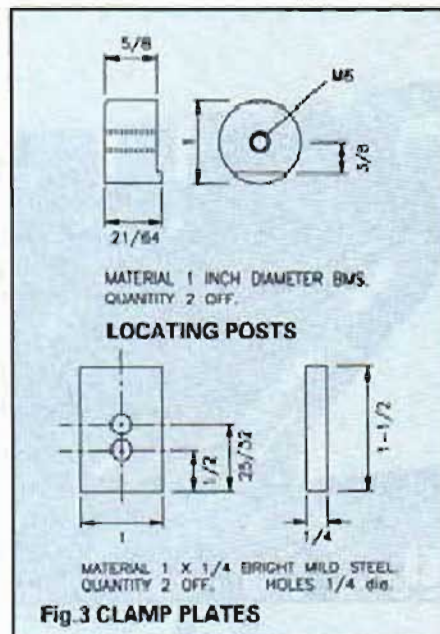


The posts were also to include the method of clamping the parallels in position; this is best seen in the drawing of the arrangement (**fig 2**).

It is essential that the outer diameter of the post is parallel and at right angles to the mounting face; if not, the top surface will not be level when mounted to the angle plate. The result of this will be that one parallel will end up wider than the other. Machining both the outer diameter and the end to be bolted against the face plate, without removing the post from the chuck, was thought to ensure this would be achieved.

Even so it was here that a situation developed that resulted in this approach being a failure! It can be seen that the post had to be mounted at the top of the slot in the angle plate.

This was to suit the narrower parallels. As a result it was unequally supported due to its base not being in contact with the angle plate round the bottom quarter. Because of this, when being tightened, the post tilted a little due to this unsupported



portion, the extent of which would make one parallel about 1 thou. wider than the other.

Anyone using an angle plate with narrower slots, or using larger diameter posts, or able to use round holes in the angle plate, may still find this approach satisfactory.

In this case though, the top surface of both posts were very lightly machined at the same depth setting to produce a near perfect result, **photograph 3**. This was done after first positioning the posts reasonably accurately as in **photograph 2**. To avoid having to machine right up to the face plate surface, a small chamfer was made to the top of the post where it touched the face plate. This can be seen in the drawing of the part (**fig 3**).

The advantage of posts over the use of, say, a continuous level face, is that it is easier to clean these after each pair has been produced. This reduces the possibility

of errors due to swarf being present when fitting the next pair for machining. One point which must be taken note of is that the accuracy will benefit from the posts being as far apart as can be achieved. For the 3 1/2 in. length of parallel a spacing of at least 2 1/2 in. should be aimed for.

In this arrangement we see a good example of the benefit of making special fixtures for positioning and holding an item to be machined, rather than to attempt to make do with the proprietary items, vices, etc, which are immediately available.

With the fixture now complete and ready for use, place a pair of parallels into it then, using a sharp end mill, lightly machine one edge (**photograph 4**). Measure the first pair to ensure they have turned out parallel, to be sure that no mistake has occurred in the set up. When confident all is OK, proceed in a similar manner with the remaining pairs.

Having machined the first side of each

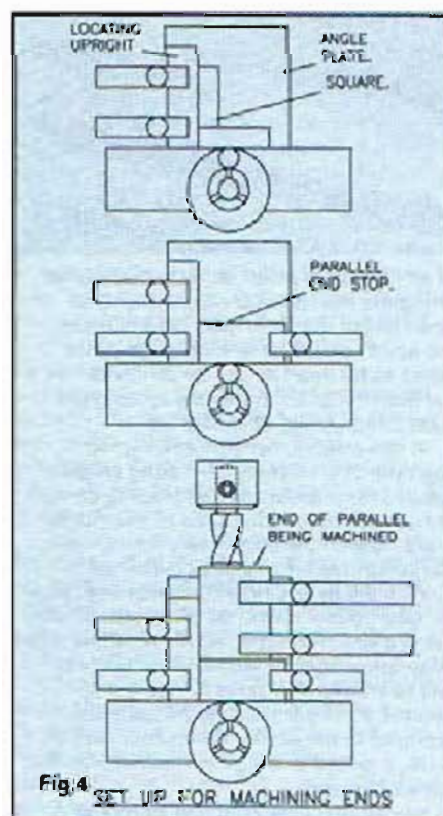


pair, turn over and machine the other edge. First measure the pair to be machined to determine the amount to be removed, and machine carefully to $\frac{1}{2}$ thou. over the required finished dimension. The arrangement for holding the parallels will permit them to be measured at the ends and also in the middle, without removing them from the angle plate.

The oversize dimension will permit the parallel to be lightly lapped on a piece of fine emery paper to a precise dimension. If total removal of the machining marks is preferred then machine to at least 1 thou. oversize.

End machining

Machining the ends is less critical, but making them all the same length and to a rounded dimension is worth aiming for.



The arrangement shown in **Fig. 4** and **photograph 5** will permit the operation to be done accurately and with ease.

As seen in the drawing, the first upright set in position using a square is primarily to ensure the parallel being made takes up the correct position to achieve a square end. The lower piece acts as a stop and will make it easy to ensure all the parallels are made to the same length.

Whilst these added pieces are primarily to locate the part being machined in the correct position, they also act as added support to it. Such supports may be worth using for added support alone in some cases, particularly where a part may be

measuring frequently until the precise dimension is arrived at.

The aim is just to remove the high points left by the machining; the dimension will reduce quite rapidly, so do measure frequently. If on the other hand it has been decided to totally remove the machining marks (there is no justification for this other than appearance), then the process will be more prolonged and some patience will be required...

If one end requires reducing more than the other, a little more pressure about $\frac{1}{4}$ along its length should cope with this. Do not apply the additional pressure too close to the end as the parallel can easily become barrel-shaped.

When this stage is complete, thoroughly clean the parallels, surface plate and measuring equipment, to avoid leaving abrasive materials to cause damage at a later date.

Storage

Not being hardened, the parallels will easily burr on the edges and it is therefore worth making a simple storage rack, as seen in **photograph 6**, rather than allowing them to just bounce around in a box.

Obtain or cut some $\frac{1}{4}$ inch square strips of wood and also a piece of $\frac{1}{4}$ thick wood for the base. If parallels are made to the dimensions quoted this should be a little over 4 x 5 $\frac{1}{2}$ inches. This allows for final finishing to size after strips have been fitted.

Cut 7 pieces 3 $\frac{1}{2}$ in. long and drill each one with a single hole say $\frac{1}{8}$ in. diameter and about in the centre. This will permit the strip to be nailed to the base without fear of



difficult to hold due to its size or shape.

First machine one end of each pair just sufficient to clean up the cutting marks. Then machine the other end to the dimension required and, working to the same index dial setting, machine all pairs to the same length. Again this can be a little over-size to permit lapping, though this is surely less important.

Lapping to size

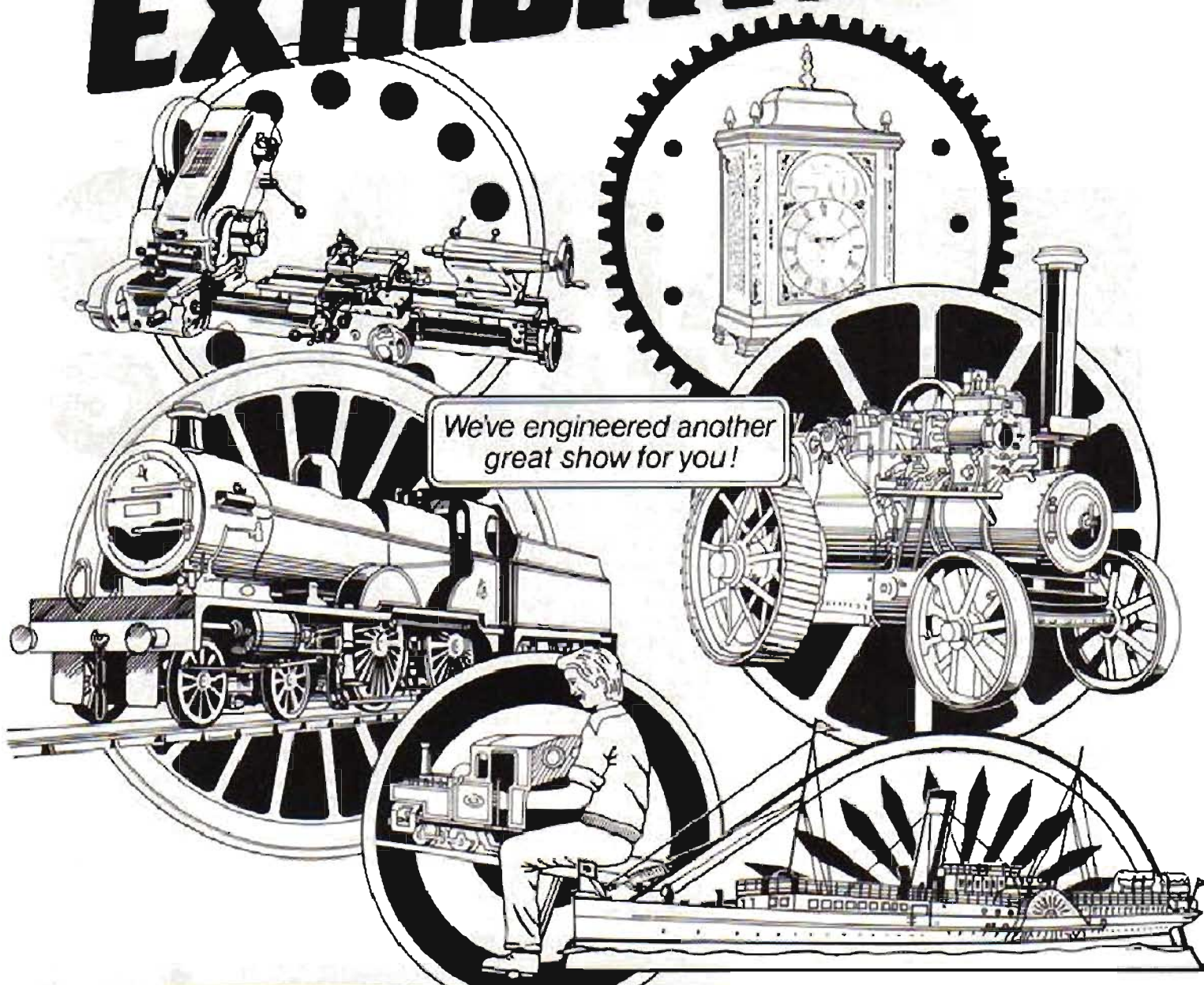
Now using a fine grade emery paper placed on a piece of plate glass or surface plate, carefully lap each face of the parallel,

splitting it — use a piece of $\frac{1}{4}$ in. wide material say $\frac{1}{8}$ in. thick to act as a spacer between adjacent strips.

Now cut two pieces of strip 5 $\frac{1}{2}$ in. long, drill two small holes for nails in each and nail to the base, close up to the end of the strips already fitted. Finish round the edge of the base to be flush with the strips, sand paper all over to give an acceptable finish and the job's done. It does not warrant varnishing but this can be done if you wish.

When complete, the parallels will find a wide range of uses and will more than repay the time taken in making them.

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A selection of the tools used in the job

BEARING REMETALLING

This detailed article on bearing remetalting is offered by 'Fettler' who has had a long association with the bearing remetalting industry.

My first experience of molten whitemetal was when, as a youngster, I was watching a bearing being 'poured' and a bead of molten metal splashed into the side of my shoe. Never have a shoe and sock been removed so quickly! Such were the joys of being born into a family firm where remetalting was a mainstay of the business.

Pre-war most automotive engine bearings (and the majority of other 'engine' applications) used white or 'babbitt' anti-friction metal as one of the working surfaces. The now almost universal 'thin shell' automotive bearings first appeared in the late 1930's.

I have seen whitemetal bearings cast directly into cylinder blocks and bored out *in situ* (an early Ford design, if I remember correctly) – it was a swine of a job to get the metal to adhere to the cast iron. The centrifugal casting of aero-engine bearings could be interesting too, especially during early (and unguarded) trials when too much metal was poured and it sprayed across the workshop, but that was in wartime and the Factory Inspectors had all been 'called up'.

I have personally re-lined plain bearings having up to 3cwt whitemetal content, crossheads, plunger blocks, thrust rings and pads, con-rods, and 'brasses' (thick

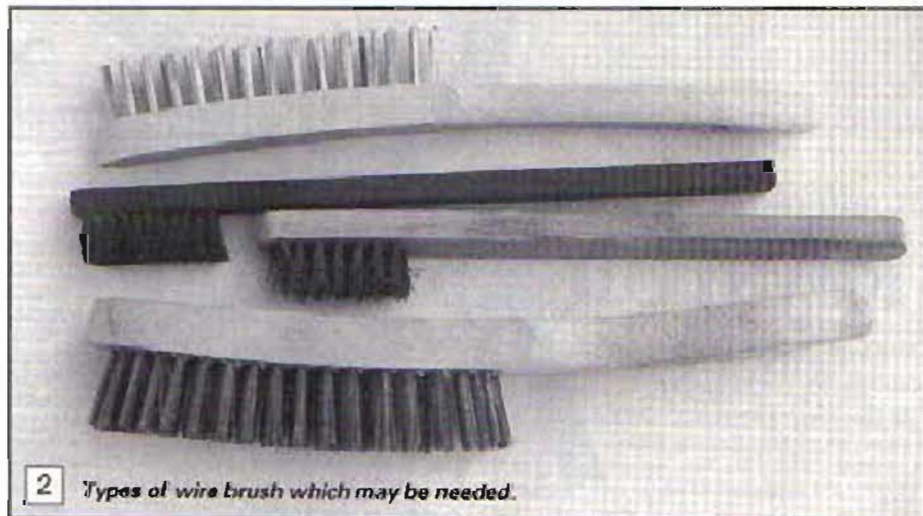
shells') in variety. Nowadays, however, modern materials have largely supplanted whitemetal for most applications (with the notable exception of large diesels and turbines) and, owing to lack of viable demand, few firms will undertake remetalting work. It is, of course, wholly inadvisable (if not downright impossible) to remetal thin shell bearings of the sort supplied in small packets to the motor trade, many of which nowadays are lined with sophisticated materials designed to withstand the higher running stresses within modern engines.

Where bearing failure has occurred in heavy plant it has been known for the babbitt to be cast 'in situ' without removing the heavy shaft, and without machining.

These instances were rare, being possible only when rotative speed was low, and where the shaft was undamaged and could be coated with blacklead both to prevent metal adhesion and to act as temporary lubrication on initial rotation until an oil film developed.

Why whitemetal?

Whitemetal bearing metal has inherent anti-friction properties, resistance to seizure, ease of replacement, acid resistance, oil wettability, conformability, ductility, good conductivity (of heat), and is able to accept – and still work with – particles of dirt embedded in its surface. Also, it does not need a specially hardened



2

Types of wire brush which may be needed.

shaft. It will not, however, stand high temperatures, excessive loads, or more than a temporary breakdown of lubrication – when it will melt and ‘run’, increasing the running clearance to produce (in the case of big-end failure) the once familiar but dreaded ‘knocking’ sound. A reliable lubrication system is essential, the oil acting also as a heat transfer medium to keep bearing temperatures within bounds.

Grades of whitmetal vary according to intended use. A diesel engine with its high loadings requires metal of very different formulation to that for (say) a stone-crusher. At ‘the old firm’ (where I took most of the accompanying photos over 15 years ago), care was taken always to match metal to application.

As a (very) rough guide, the higher the tin content (as opposed to lead), the better the metal quality. Copper and antimony also appear in the formulation, as do small amounts of other elements which are added to improve the suitability of the metal to particular uses. The inherent ‘softness’ of whitmetal is overcome by keeping its thickness to an acceptable minimum. This also reduces costs – babbit is far from cheap!

So you want to try your hand?

I shall describe, in very general terms, what is involved in metalling bearings.



Square blocks are Babbitt metal, horseshoe shape is tinman's solder

sit them over the gas-rings, an iron self-skimming ladle for stirring and pouring the metal, and a couple of pairs of tongs for handling hot things. Next, you need an old tin for dross (it's valuable scrap), wire brushes, a flux brush, rag (not wool or artificial fibre), ‘Bakers’ liquid flux and a container to use it from, old and dreadnought-cut files, soldering iron, dipping wire, blacklead, fire-clay and a couple of empty tins for it, emery cloth, a 1lb ball pein hammer, some old sump oil, tinman's solder (high tin content, or pure

are not essential. With the improvements in machining techniques they have comparatively limited use nowadays.

I suggest (with the usual disclaimer) that any reader seriously contemplating remetalting might contact Hoyt Darchem Ltd., Garth Road, Lower Morden, Surrey, SM4 4LT, for supplies. They sell remetalting equipment, tinning compounds, fluxes, luting material and, of course, a whole range of whitmetals. Another supplier (same disclaimer) but of whitmetal only is The Glacier Metal Company, Talbot Road, Stretford, Manchester, M32 0XT. Both these companies and LVW Senar Ltd., of 118 Cleveland Street, Birkenhead, L41 3QP, undertake remetalting work. (There must be more who do it). There may also be local stockists in our main ports, as ships usually carry an emergency supply on board. Don't be tempted to use the so-called whitmetal used for small model castings, its prescription is unsuitable for our purposes. 5-notch, 6lb ingots used to be standard but metrication must have polluted the system by now. The pieces in **Photo 3** are make-weights.

Working environment & safety

You can't do the job outdoors because of draughts, but adequate ventilation, including the extraction of burning oil and acid flux flames, is absolutely essential. DON'T attempt it inside your house (if that's where your workshop is), or in a place where there's bright metal (as in your usual workshop) because you'll get serious rust problems from the flux fumes. A fireproof shed away from the house is probably best. If you use your garage and leave (as you must) the door(s) open, check that fumes don't rise up into next door's open bedroom window – unless you plan to emigrate next week!

Understand this: remetalting is a hot, smelly job. Wear boots, old clothes, an old (or leather) apron, eye protection, and barrier cream on your hands. Think carefully about using gloves; a bead of metal is better bouncing off your skin than going inside a glove while you're doing a tricky pouring operation – the decision is yours.

You need a metal topped bench (or large steel sheet) on which to work and place your equipment. Make sure that everything is to hand, checking that you won't try to reach for something through a flame. Think also of the rising heat – you don't want your roof on fire!

Readers who are used to silver-soldering or brazing copper boilers may already have a suitable place to work, but metalling needs more space and is a dirtier operation.

Making a start – jigs

I can only generalise because these depend on the style and design of the work in hand.

Examine the bearings carefully, noting shape, size and location of oilways and reliefs, thickness of ‘end’ metal (on thrust faces), length, width over butts (housing diameter), shaft diameter, radii, etc., and particularly, datum points from which to set up for finish machining.

Split bearings will need to be clamped lightly to a plain angle-plate jig (a small version of that in **Photo 11**, see **Figure 1**), whereas tubular bearings (bushes) can be



Brasses such as these are commonly used as backing pieces

Finish-machining operations follow usual workshop practice. There's nothing daunting but, like everything else, care, equipment, and skill born of practice, all have their input. If you have in mind only model bearings, maybe for a locomotive, by all means read on, but also read Roy Amsbury's article in *Model Engineer*, Vol. 155, No. 3758, of August 2nd, 1985*. I shall deal with larger work of up to 3" diameter. (* See postscript at end of article – Ed)

Equipment and consumables

First, you need a heat source – mains gas or LPG – not oxy-acetylene, with an air blow-torch and (preferably) two gas rings. (In the old days you would have needed two or three large capacity paraffin blow lamps). You'll also need a plumber's spelter pot (preferably two), with stands to

tin) and, I'm tempted to say (after having re-read that lot), a good bank balance to buy it all – and you haven't bought the babbit or made the jigs yet! Neither have I mentioned the range of engineers' tools from scriber, callipers, rule, and the like – through to machine tools with which finally to bring the job to size. No wonder metalling is costly to have done for you!

You can improvise some of the tools for small or one-off jobs but I'll leave that to your own discretion. Remember that whitmetal is heavy to handle and that it will dissolve silver solder, ‘brass’, and brazing alloy, so if you're thinking of making your own equipment then use iron rivets or weld it.

To some older engineers, the scraping of bearings was synonymous with fitting and, although I show scrapers in **Photo 1**, they

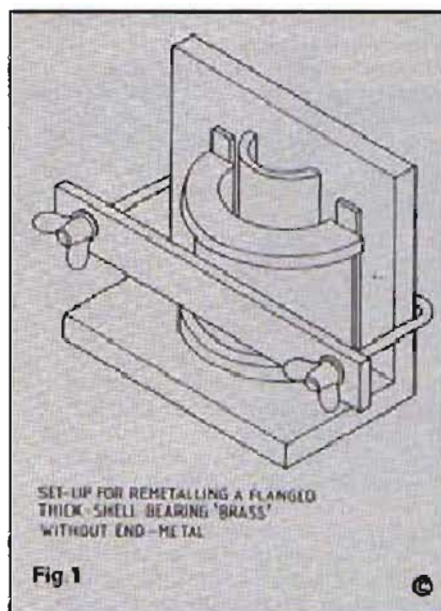


Fig 1

held down (to stop them floating on liquid metal) to a flat plate jig with a central core attached (Figure 2). If end-metal (on thrust

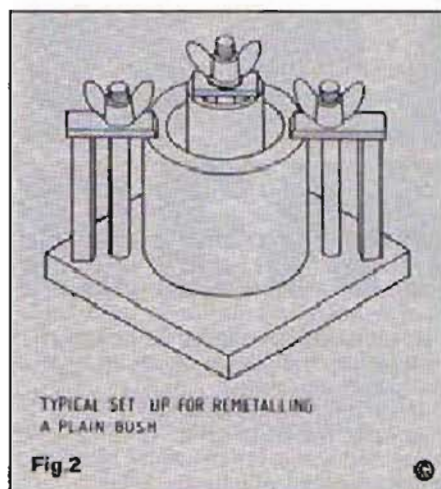


Fig 2

faces) is needed, then either semi- or circular formers must be made to suit. You will also need mandrels or cores to take up most of the volume of where the shaft would be (leaving a healthy machining allowance), and to save having to pour too much metal. Cores should be hollow, or of thick sheet steel, to permit rapid heating and cooling and, if circular, they should be tapered to facilitate removal. Use slack-threaded wing nuts on studs and fixings for ease of assembly and dismantling when hot.

It is usual (other than for batch or production work) to have to make up jigs for each job. Use cast iron (preferably) or steel. NEVER use bronze, brass, or stainless steel. Mild steel shims at least 1/8in thick may be necessary to ensure enough metal at the butts of half bearings, or as a ring mould to fit round small crosshead sliders, thrust pads, etc., or to keep half bearings separate when cast as a pair around a central core. Most jigs can be quite crude and are readily made from bits of scrap.

Jigs must be treated to prevent the babbit from adhering. Either use layers of liquid blacklead ('Zebco') baked on, or burn-on old sump oil to build up a black surface to prevent tinning. Rust, too, has advantages in this respect. Treat similarly

any clamps that may come into contact with molten metal.

New metal pots and ladles should be coated internally with a mixture of plain oil-bound water paint (not vinyl emulsion) and sodium silicate (waterglass). Brush it on thoroughly. The same mixture is also useful as stopping, to prevent babbit adhering to places where it's not wanted.

Con-rods, because of their length, used to be metallised while held vertically in a special-purpose jig. It was a three-handed operation to set things quickly while hot, so

stopping anywhere near the surfaces to be tinned. In the old days, we used wet asbestos millboard for the larger cavities, but that's forbidden now and has been replaced in remetalling shops by asbestos-free fibre putty.

Having done this, it's wise to have a handling rehearsal with the tongs before things get hot. This will improve your confidence for later.

Now's the time too, to light the gas under the metal pot, pushing the ingots into the bottom as they melt.



A close-up of a damaged brass.

the jig had a foot operated, spring loaded end-clamp to grip the workpiece (as in a vice). The cast iron cores, set horizontally and resting on end-clamps (which also controlled the amount of end-metal), were drilled to act as ingates for the babbit which then rose up either side to form a meniscus at the butts. Home workers will have to do the job side-on, as for half-bearing caps, with the overhanging small end supported on a wedge, and with half-ring jigs to accommodate the end-metal.

Running-out

Light your gas-torch and generally heat the bearing so that the old metal melts and runs out, catching it in an old tin or tray; you can assist the process with an old knife or hacksaw blade. It's good metallising shop practice to avoid (as far as possible) playing the flame directly onto whitmetal surfaces.

If you've already accumulated a pot of old whitmetal, bearings can be both heated and run-out by dipping them in this. (It can also be used for pre-heating jigs). It's a lot less messy, but make sure that work is warm and dry first. Avoid the fumes.

Tinning

While the bearing is hot check that the stopping doesn't need further attention, then give the surfaces to be tinned a good wire brushing. Brush on some Bakers flux (nasty fumes) and rub the surface all over with tinmans solder or commercial tinning compound, scratch-tinning with a small wire brush where necessary. Re-heat as needed. Check that the entire surface is



A large bronze bush which is to be white metallised.

Workpiece preparation

Degrease the bearings thoroughly, otherwise the stopping or luting won't adhere and the oil will have to be burned off.

Steel bearings and 'brasses' must be covered with blacklead, liquid clay, luting, or equivalent (as mentioned above), to prevent their being tinned in unwanted places when running-out the old metal and during remetalling. Cast iron seldom needs this treatment unless newly machined. Stop-off oil and bolt holes with clay or fireproof plaster to prevent metal penetration, but be careful not to get

tinned and shiny with molten solder, particularly at the edges where it is essential to ensure a good bond (don't get things too hot). If the surfaces were good and clean to start with, a quick wipe with a rag over the molten solder may be all that's needed.

Small bearings can be dip-tinned in a second pot of metal, scrubbing and fluxing as necessary. (We used pure tin years ago, but that's fiendishly expensive). DON'T put a damp or cold bearing into molten babbit; it will sputter dangerously. Also, never be tempted to let a 'brass' soak in the metal because it will slowly dissolve, ruining both

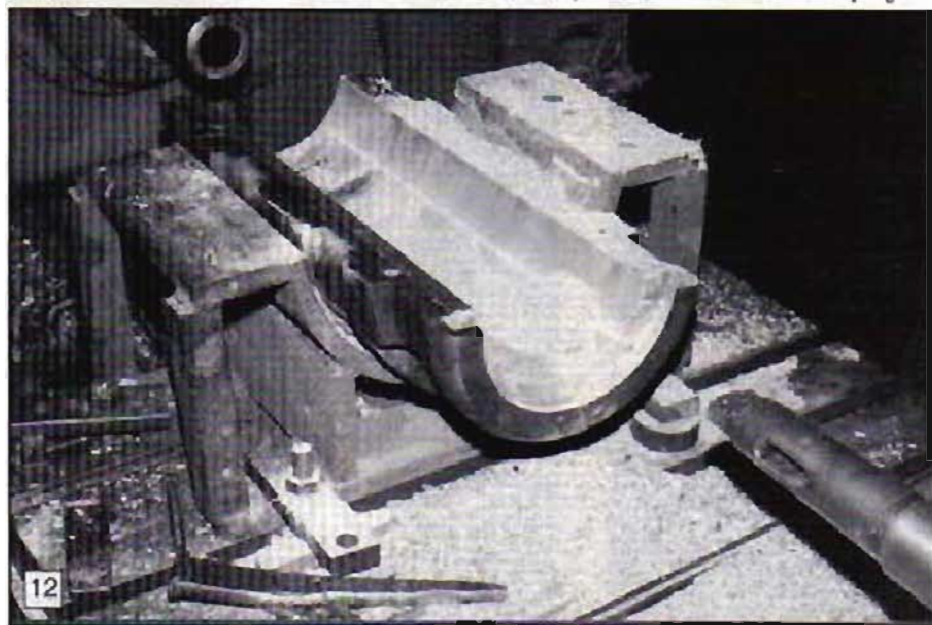
brass and metal. I've known of brasses being forgotten and lost for ever that way!

Unless new and NEVER touched by oil, it's almost impossible to tin cast iron properly. Most such bearings have dovetails and recesses machined into them for the babbitt to key into. Make sure that these are as clean as possible, giving everywhere a good scrubbing with the scratch-tinning brush to achieve a grey shiny surface. Even after your best efforts oil may still exude from the pores in the metal.

hammer shaft slightly on removing, and that should be all that's needed. A dab of liquid clay applied with an old paintbrush is often effective too. Start pouring again as soon as possible. When I was doing this regularly and was used to the heat I would use my finger, the dried clay caked on my skin prevented me from being burned. DON'T try it - there's a knack!

Pouring the melt

In the absence of a suitable thermometer the temperature of the melt can be judged



Proof boring a fan bearing after re-metalling

It doesn't matter if the bearing cools a little while we enter the next phase, but heat retained is heat saved and speeds the job.

Preparation for pouring

Prepare and warm the jigs. Make sure the mandrel is central and appropriately clamped, using clay or luting to seal the joints to prevent molten metal rising up the inside. Place formers for end-metal as required, then position the bearing, not forgetting loose shims at the butts. Clamp it in place, making sure that gaps between workpiece, formers, shims, and jig, are at an absolute minimum.

Now take fingersful of soft clay and quickly (and thickly) smear it all over the outside joints to act as a sealant to stop molten metal escaping and being wasted. The taller the set-up, the greater the pressure, and the more likely the chance of a leak. Do the job thoroughly, adding more clay as needed. It will dry quickly against hot surfaces, but the remainder will stay damp.

Position top end-metal formers as required and play your torch over the whole assembly to dry it out and bring it to pouring heat. It's important to get the core (mandrel) hot enough, particularly at the bottom; so it's helpful to arrange things so that the gas-torch can be aimed underneath the assembly as well. The clay must be baked dry otherwise there is a danger of steam causing porosity in the whitmetal.

If, later on, a leak appears during pouring, don't panic. Stop pouring, put a ball of soft clay on the end of your hammer shaft, press it over the leak, twist the

roughly. If too cool, there will be crystals of metal present when stirred. When right, metal will run freely from the ladle and a piece of brown paper will start to darken but not burn when dipped. If too hot, oxides and dross will rapidly form on the surface and the metal will 'burn' and deteriorate. The pouring temperatures of most babbitt metals lie in the lower part of the range 390° to (say) 450°. Temperature colour sticks are available commercially, as are comparatively cheap simple metal thermometers.

The temperature of the bearing and jig should be such that the tinned surface is just beginning to glisten and 'cry' or 'sweat' as drops of metal appear. Don't overheat. 400° is a good maximum. Check recommended temperatures with the metal suppliers - so treat my figures as a rough guide only. No 'clever' letters please!

Stir the metal well, skim off the dross, and take a ladleful and pour it carefully into place without splashing. If 'icicles' form, more heat is needed. Aim for continuous steady pouring until the jig is full. Light your gas-torch to keep the upper part hot while things cool from the bottom upwards. Using your dipping wire, dip the metal to remove air pockets and prevent blow-holes. You will feel the metal turning to mush from the bottom as it cools. Aim to let this mush develop evenly upwards as cooling progresses, applying heat as necessary towards the top to keep that end liquid until the last. All the time the metal will be contracting and shrinking. Top-up with more metal as needed. Continue this sequence until the top end-metal is sufficient and has become solid. Turn off the gas (unless there's more to do), and

Quick Tip (with a difference)

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carefully dismantle the set-up. Empty the metal pot, casting what's left of it into an ingot for next time.

Examination

Break away and clean off clay, dried luting, and metal tears.

There should be no blowholes, shrinkage cavities, or porosity where the metal has cooled too quickly and shrunk. Check that the end-metal is sufficient, and that the bonding around the edges is good. Lightly tap with a hammer to hear if the bearing 'rings' or sounds dead (useless for cast iron). If you're dissatisfied, then do the job again. If all's well, you can feel proud!



An early electrical means of testing for proof of bond between Babbitt and backing metal following machining. This "thick shell" is from a large gas engine.

Further considerations

The bearings should now be fettled with a coarse or dreadsought file, and the backing cleaned by wire-brushing in readiness for proof boring as for any casting. Thoroughly clean out the stopping from all holes and cavities.

Very small blowholes can be filled by using a soldering iron to add whitmetal locally from a thin cast stick using standard soldering techniques.

Large half bearings tend to distort during remetalling and may have to be brought back to size so as to fit their housings. Usually the horns close-in and have to be spread by the judicious use of a hammer and wood block on the O.D., or by evenly peening the whitmetal surface with a ball peen hammer to relieve internal shrinkage stresses. If the horns have





13



14

7: Running out over a hot plate.

8: A half bearing after pouring.

9: Breaking the clay from the mould.

10: Easing the newly metallised bearing from the mandrel.

11: A well cast job.

13: A pair of finished cap and rod bearing.

14: Machining a special purpose solid white metal bearing.

Proof boring now follows and, for all except cast-iron backed bearings, professionals would recheck the bond (adhesion of babbitt to backing metal), possibly by electrical means as in **Photo 15**.

Con-rods are usually machined in special jigs. Myford listed such an item until recently for use on their range of lathes. Such (or a purpose built machine) is almost indispensable, as it greatly simplifies and facilitates the boring, re-boring, facing of end-metal, and cutting of reliefs and oilways in the same set-up – and with the added advantage of repeatability of big-end to small-end centre-distance throughout a batch. Tools should be keen, broad edged, and with a slight top rake to give a perfect bright finish to the work. NEVER use emery on babbitt metal.

Turnings can be collected and re-used, but only for low-grade work because of the

Quick Tip

When intending to use the tailstock of the lathe, the first habitual action is to check for swarf in the Morse tapered bore. Logically a better idea is not to allow swarf to penetrate into the bore in the first place. A simple plug for a No. 2 Morse is a dry wine bottle cork!

E.R. Whiffin

dirt and foreign metal (steel and brass) content. Melted down with old run-out metal they could be cast to form artificial housings for use as boring fixtures as in **Photo 12**. Or, if you are a model maker, such could be used for loco wheel balance weights, or ballast weights, or simply sold as scrap for recycling – it's still worth a bob or two, so never waste it!

Last words

Metalling is a vast subject and bearing types are almost limitless beyond description. I have given, within the space available, only a minute insight into this huge topic and, regrettably, in nowhere near as much detail as the subject warrants. I hope I've been of help to those readers contemplating having a go for themselves.

For those who think remetalling is 'archaic technology' here, in the summer of 1992, there are Formula 1 racing cars using whitmetal bearings in their transmission systems, 153 years after Isaac Babbitt patented the stuff!



Readers wishing for a photocopy of the M.E. article mentioned should send details of the article (date & title), together with a cheque for £1.50 (U.K.) or £2.00 (Overseas) to Argus Specialist Publications, Photocopy Service, Argus House, Boundary Way, Hemel Hempstead HP2 7ST - Ed).

spread (unlikely in my experience) squeeze the bearing gently between the vice soft-jaws. Check sizes constantly until they match those noted initially.

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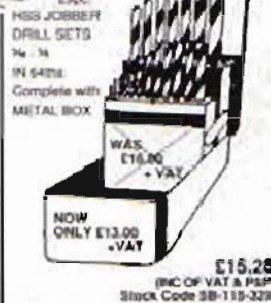
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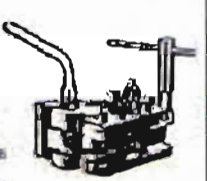
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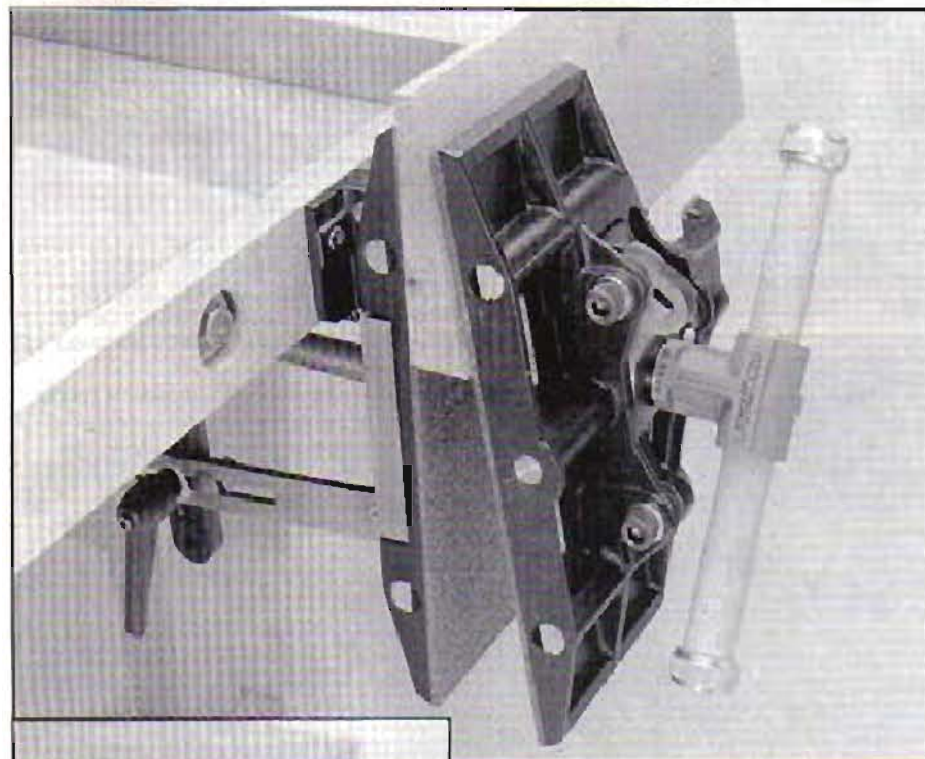
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Another variation in workholding from the same piece of equipment, seen here firmly holding a tapered wooden section. The uses seem limitless.



The Tucker ZA-12 Supervice, workholding in horizontal mode.

Ed Tucker, a retired Canadian pattern maker, decided he would have a go at recreating the old pattern maker's vice using modern materials and some new ideas of his own to create a Super-vice – light and versatile – that would better the old pattern maker's vice. The result of four years of intensive research and development is the "Tucker" ZA-12 Super-vice featuring:

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For more information contact: Hegner U.K., Unit 8, North Crescent, Diplocks Way, Hailsham BN27 3JF. Tel: Hailsham (0323) 442440.

Another item of particular interest to the woodworker is the electric sharpener from C.Z. Scientific Instruments Ltd.

Electric sharpeners

C.Z. Scientific Instruments Ltd. are pleased to announce exclusive distribution in the U.K. and Ireland for the newest Filippo electric wet-stone sharpener from Femi of Bologna. Italian flair has produced the ideal design for this exceptionally neat product, incorporating functional simplicity with excellent performance. Particular emphasis has been placed on safety with a thermostatic cut-out to prevent overheating of the unit.

With a wheel diameter of 100mm and a grinding speed of 250 rpm, this practical and inexpensive wet-stone sharpener/grinder will be an instant favourite amongst DIY enthusiasts, craftsmen and woodworkers. Water is poured into the sealed grinding wheel housing and a detachable rest allows the appropriate sharpening angle to be selected. Recommended retail price is £34.00 plus VAT.



The Filippo Electric Wet-stone sharpener, now distributed by C.Z. Scientific.

Also available from the same importers is the heavy-duty professional model No. 177 with a larger 200mm grinding wheel. This model is designed for those users who sharpen blades throughout the working day, e.g. butchers, restaurants, hotels and caterers.

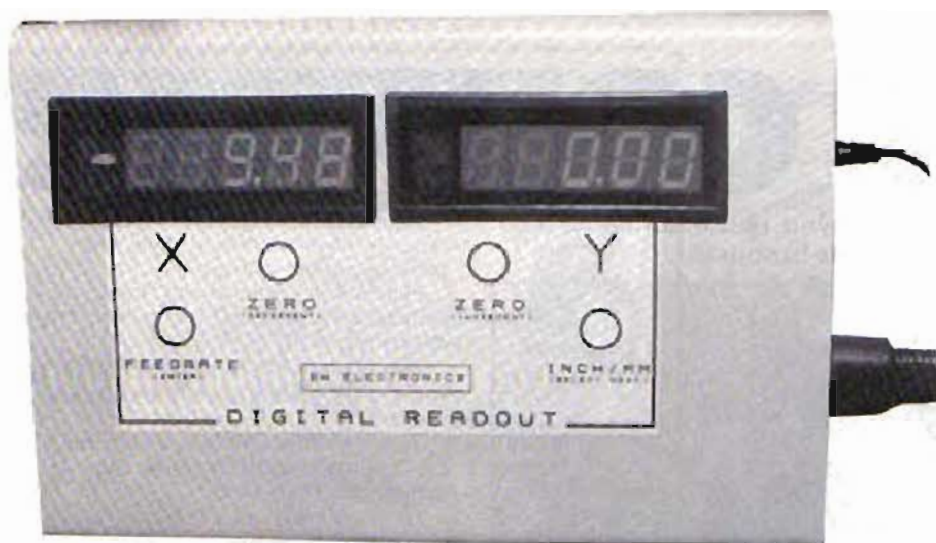
Incorporating the same essential design features of simplicity, safety and practicality as the Filippo, this unit will give years of service at a highly competitive price. Recommended retail price is £99.00 plus VAT. More details are available from: Industrial Equipment Department, C.Z. Scientific Instruments Ltd., PO Box 43, 1 Elstree Way, Borehamwood, Herts. WD6 1NH. Tel: 081-953 1688.

The same vice, seen here in the conventional position

Woodworker's vice

The many readers of MEW who are interested in woodwork, will find this woodworker's vice supplied by Hegner U.K. worthy of consideration.

The humble woodworker's vice has hardly developed in concept or design since medieval times. The greatest development took place during the Industrial Revolution with the demand from pattern makers for a versatile vice that could hold awkward shapes securely. As the demand for loose patterns declined with the development of more efficient ways of casting, the pattern maker's vice and the advances made in vice design slipped into obscurity. Just the memory of the capability of these vices lingered on in the minds of a few old hands. A few attempts have been made in the U.S.A. to revive the old pattern maker's vice with the production of direct copies. However they were too large and cumbersome by today's standards.



The digital readout unit supplied by B.W. Electronics.



The sensing system. These are manufactured in varying lengths to suit the intended application.



Operation is very repeatable. This toothed belt system is one of the options available.

Low cost digital readout

These new, relatively low cost, Digital Readout Systems can be obtained from B.W. Electronics, 39 Goldington Road, Bedford MK41 0DS. Tel: 0234 219756.

The digital position readout replaces the existing feed screw calibrated dials with a separate position measuring system. By attaching a measuring system directly to each axis the readout is made independent of any feed screw backlash. This backlash free position is shown on a large illuminated display that is much easier to read than the feed screw dials. The co-ordinated position display has two axes and is continuously updated as each axis is moved. At any time the display can be changed to show the position in either inch or metric dimensions. The convenience of zero settable feed screw dials is obtained by zeroing either or both axes at any time to set a datum point. If the axes are not zeroed then the display shows the total offset from the last datum point set.

Note the following useful features:

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Operating temperature 0 to 35°C ambient for both readout and power supply.

Can be fitted to a lathe and many other types of machine tool.

Calibration of sensor sensitivity allows the readout to be used to display any type of information obtained from an encoder, for example a position expressed as a percentage of maximum or of fully open etc.

Can use any two channel quadrature encoder with standard logic level outputs.

Calibration factor for both axes can be individually set.

Allows the positive direction of movement to be defined.

Can automatically power on in either inch or metric.

All calibration information stored when power is off.

Position sensors designed with interface positioned at the end of the sensor allowing easy fitting due to small size.

One range of position sensors can be trimmed to length on site if they are too long.

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A range of short sensors with a basic resolution of 0.001in. or 25 microns and lengths of 3in. 75mm - 4in. 100mm - 6in. 150mm - 8in. 200mm - 10in. 250mm - 12in. 300mm - 14in. 350mm.

Eclipse Permanent Magnetic Positioners

A number of readers have told us that they are somewhat confused as to the types of magnetic positioners described briefly on pages 46-47 of the August/September issue of MEW. In order to show the types available, we are

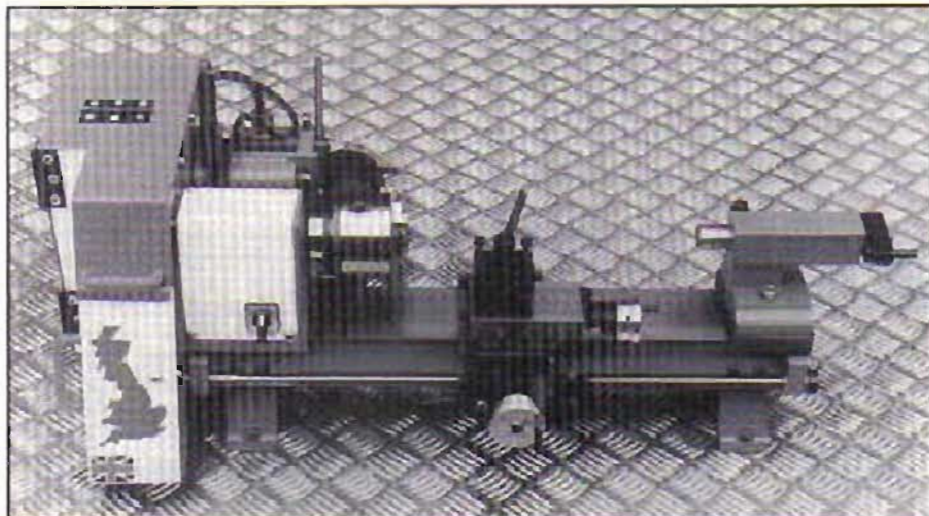


publishing a photograph of the three types described. Top left is the 920 Magnetic Adjustable Link, top right is the E951 Magnetic Quick Clamp, and bottom is E952, The Magnetic Variable Clamp.

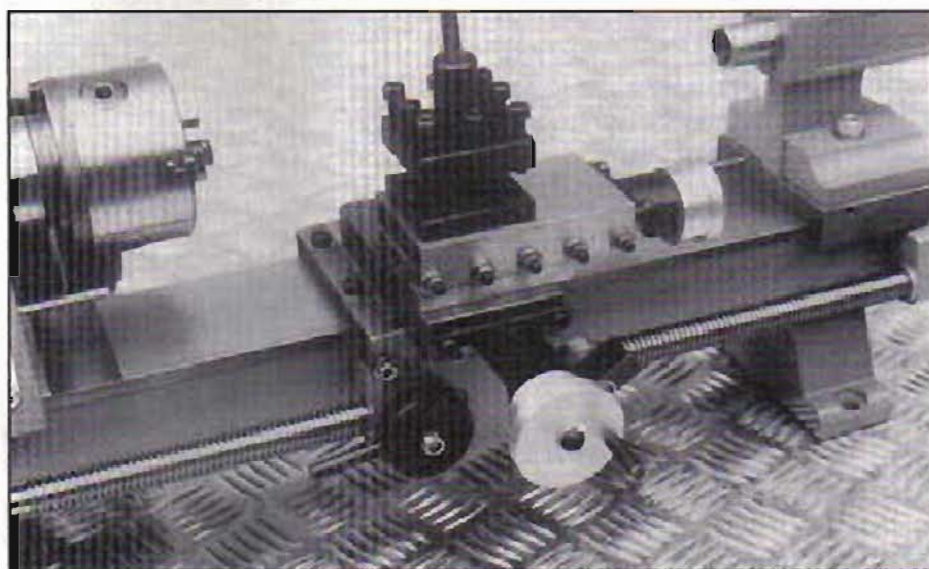
Full details of these and the many other magnetic products made can be obtained from Eclipse Magnetics Ltd, Unit 1-4 Vulcan Road, Sheffield, S9 1FW. Tel. 0742 560600

Machine Mart Ltd

Machine Mart have opened their 27th store, at Bishop Street, Coventry. This is one company which is definitely expanding despite recessionary times. A free 116 page catalogue can be obtained; ring 0602 411200.



The assembled 3 1/2 in. Project lathe from L.W. Staines & Co.



A close-up of the same lathe.

Project lathe kit

At around £500.00 inc. VAT and delivery, this British lathe in kit form looks like an interesting project and good value for money. It is also available assembled and with chuck and motor at around £800.00 inc. VAT and delivery.

The idea behind the Project Lathe Kit is quite simple! All machined components for the lathe are manufactured in the company's own factory, to save space and to prevent damage in storage, lathes are not assembled until ordered by retailers. By offering these fully finished machined components plus all bearings, fasteners, vee belts, hex keys etc. to the model engineer, considerable financial savings can be made over the cost of the assembled machine.

Assembly is a straightforward task and is well within the capabilities of the "apprentice" model engineer. In the event of any difficulty during construction the firm are always ready to give advice.

Fully assembled Project lathes are available from stockists throughout the country or in case of difficulty directly from the factory. Project lathe kits can be obtained from certain stockists.

Purchasers are welcome to collect either kits or complete machines from the works, but as a busy manufacturing company, the

firm insist that this is on a strictly appointment-only basis.

The Project offers excellent value for money but if either during construction or use the customer have any ideas to improve it the firm would be delighted to hear from you.

The machine illustrated has been built from a Project kit and to demonstrate the finish that can be obtained by the home constructor, has been finished with standard acrylic car spray aerosols.

Specifications

3 1/2 in. centre height
14 in. between centres (approx.)
4 1/2 in. dia. swing over cross slide
4 1/2 in. cross slide travel
3 in. topslide travel
Headstock taper No.2 Morse
Tailstock taper No.2 Morse
Leadscrew 1/2 in. o.d. 8 tpi acme form
Cross slide feedscrew 1/2 in. 10 tpi acme form
Topslide feedscrew 1/2 in. 10 tpi acme form
Dial graduations 0.001 in.
English pitches 4tpi-40tpi
Metric pitches 0.3mm-3.5mm
Feed range 0.0039-0.040 in. per rev
Headstock spindle bored 1/2 in. clear
6 speeds 75rpm-1600rpm approx. using 1440 rpm motor

Standard features

Stress relieved cast iron bed
Cast iron slideways
30 degree dovetails on all slides and bedway
Taper roller bearing headstock
Split nut leadscrew
Thread indicator/rapid carriage traverse handle
Set over tailstock
Tailstock self eject
Swivelling topslide
4 way toolpost
Low speeds via backgear

For details contact: L.W. Staines & Co., 8 River Road Business Park, 33 River Road, Barking, Essex IG11 0DA. Tel. & Fax: 081-591 2900.

Sources of supply

I would like to thank the reader who have provided the following information. These are in reply to requests for materials and tool suppliers in previous issues.

1. Soft iron for electro magnets. Goodfellow Metals Ltd. Cambridge Science Park, Cambridge CB4 4DJ. This company stocks a very wide range of metals for research and industry. They have no minimum order charge.

2. New and second-hand electric motors. Frank Smith Electric Motors, 26 Victoria Road, Pinxton, Nottingham NG16 6LR. 0773 810238.

3. A company who will sharpen milling cutters and the like. Bromac Regrinds Unit 1, Mobile Home, Noke Lane, St. Albans. 0727 865408.

Last month's requests

These did not bring many replies so here they are again, can anyone please help?

1. Tin Plate of about 24swg or 0.5mm (material from oil cans is too thin. Is there a supplier who can supply small sheets, say 500mm sq. or maybe a user who would be willing to make available pieces from their scrap bin?

2. Half round brass strip.

3. Electro Plating Materials.

4. Company to carry out electro plating in small quantities.

5. Shield gases for MIG welding.

Some new requirements

1. Shim Steel having sizes in one thou.

steps from 0.004 in. to about 0.025 in.
2. Straight flute or slow spiral flute drills for brass.

Can anyone help with information on sources of supply for these items?

Local suppliers of raw materials

It is obvious that readers are looking for local suppliers of raw material where they can call and purchase small amounts, particularly larger sizes. This should preferably be without a minimum order charge or at least a low minimum order charge, say £5.00.

Gratton Model Engineering, 39 Whittaker Street, Derby. 0332 764301/49799.

Stainless and Engineering Alloys, Unit 4, The Drawing Court, Grimsby, South Humberside DN31 2TN. 0472 344832. This company has a catalogue.

Do also please support the many suppliers who advertise in MEW.

I will be pleased to continue to publish names of similar local suppliers if readers will send in details.

FULL-SIZE PULL OUT PLANS PROJECT

A JECLANIDE HANDWHEEL

This intriguing device by W.B. Taylor will serve little purpose other than to promote much discussion between all those who are shown it! It does, however, provide some interesting machining operations and could be made and finished to a high standard in which case it would make a nice Christmas present as an executive toy for that friend who otherwise has everything!

Not only did it play an essential role in an elaborate drive system, its unusual performance made it an intriguing little gubbin in its own right.

In today's jargon the jeclanide handwheel is 'transparent' when operated from one end — and rigidly 'solid' when torque is applied to the other.

The prototype was one of a number of home brewed gadgets scattered round your scribe's office. (The forerunners of today's Executive-Toys?).

Clamped to a convenient support, it roused the interest of many clients. By twiddling its handwheel, they could swing a weighty lever arm from the nine o'clock to the three o'clock position, never failing to be intrigued by the way the arm stubbornly refused to budge from any lopsided position set by the handwheel.

Its silver steel shaft carried battle scars, ample evidence that over enthusiastic types had used excessive force against the little man inside — but he always stood his ground.

Top secret!

Curiosity fed most observers to request a view of its innards. Repeated dismantlings accompanied by a need to smooth away the shaft's latest crop of wounds prompted a larger version in Perspex, its modus operandi thereby exposed to view. Glass clear and polished it never failed to gain attention and, like its smaller brothers, proved capable of resisting any tendency to rotate when unbalanced loads were applied to its silver steel shaft.

The original device played an essential role as part of a drive system built into a large training aid supplied to the M.O.D. To

avoid violating the terms of the Official Secrets Act, let's call it a display based on the pigeon and its homing instinct...

Incidentally, the display mechanism had to incorporate an 'inertia factor', the attack and decay time being influenced by the distance between pigeon and loft. (It was essential for the display to include a symbolic time lag to indicate inertia effects in the full-size system. In real life, there's time — and occasionally a need, for a prayer meeting after slamming on the brakes of a supertanker, for instance).

But first a word about differential gears, six of which — all interconnected — were incorporated in the display drive. Perhaps the most familiar application of a differential gear is that located in a car's rear axle; the drive being applied via the prop-shaft and crown bevel gear to the planet gear spider and thence to the sun gears on the two half-shafts driving the road wheels. Viewed from above it follows a basic 'T' shape; the input applied via the leg, outputs taken from both ends of the cross bar.

Spot the differential!

Diagram A identifies components of all six diff units incorporated in the display mechanism. A typical diff assembly is also shown. (Together with notes relative to the specific unit by which the instructor fed commands into the display, about which more below).

Instead of driving the spider by a crown wheel, the spider-boss (B) complete with two stub-shafts is fixed to a central shaft (A). Two bevel planet pinions (P) are free to rotate on the spider stub-shafts, held captive by circlips and washers.

A pair of bevel gears (S) — the sun wheels — are free to rotate on the central shaft (A), again held captive by circlips and washers. Both sun wheels have spur gears (G) attached, their PCDs selected according to the ratio required when meshed with their respective drives. (We obtained all our gears from S.H. Muffett Ltd, Tunbridge Wells, Kent — usual disclaimers — but for those interested in building an experimental diff, take a tour round second hand shops and select two identical bevel drive hand drills).

The display had to reproduce all aspects of the cause, effect and corrective measures used in restoring a disrupted state of equilibrium so, as may be expected, some of our diffs operated in the

car-mode, others followed a slightly different operating mode whereby two inputs were applied to the ends of the 'T' cross bar and the result taken from the leg.

With reference to the assembly in **Diagram A**, the instructor's jeclanide handwheel rotated the manual input of a diff operating in the double input mode, ie, turning the handwheel rotated the 'manual' sun wheel (MS) of the pair, the other sun wheel (PS) being coupled to the power driven mechanism. In the neutral or equilibrium state, the differential unit was at rest. (ie. the pigeon in its loft). By turning the handwheel, the instructor could move the pigeon to some remote spot, thereby disrupting the status quo.

At the differential, the high resistance to rotation of the motor driven mechanism ensured that sun wheel (PS) was too stiff to be turned by hand. Consequently the rotation applied by the instructor to his manual sun wheel (MS) caused the planet wheels to roll round the 'drive' sun wheel (PS), thereby rotating the spider and its carrier shaft (A) away from the neutral equilibrium position.

From a slow start, the mechanism gradually responded to the non-neutral state, the power drive rotating its sun wheel in the correct direction to restore matters. It gradually decelerated as it approached neutrality, so preventing an overshoot as the spider and its shaft regained the original neutral position.

Needless to say, there was much more to the system, but it was vital that whenever power was applied, it caused the planet wheels to roll round an unyielding manual sun wheel, otherwise, instead of returning the spider shaft to its original equilibrium position, the power drive would merely spin the handwheel. Consequently it was necessary to prevent the manual sun wheel from rotating when twisted from the diff end while at the same time leaving it completely free to turn either way when twisted from the instructor's end.

Clutching of straws

A self-sustaining worm drive would have involved far too great a reduction and was ruled out as too slow. As we suspected, no manufacturer bred mongrels to meet our spec. Some sales staff tried to convince us that a pair of one-way clutches would do the trick, initially failing to grasp that what we required was no ordinary

one-way clutch unit but one which presented a non-resisting drive when twisted either way at its input end and a rock-solid resistance to any twisting at the other.

Telephoned enquiries elicited a good natured: 'and the best of British luck'. Written enquiries took longer to get a similar message in writing.

Once again we were on our own.

One German manufacturer sent a sample one-way clutch which provided an opportunity to study its innards; virtually a stub-tooth ratchet wheel with a spring loaded roller sitting in each tooth and surrounded by a brake drum. Turn the ratchet one way and the rollers wedged solid between teeth and drum, turn it the other way and it free-wheeled.

It took a while for the penny to drop, yet it stared us in the face. Stripped to its components, the outer drum, ratchet, rollers and springs lay in a tray. Tying around with the bits, the ratchet was replaced in the drum along with one roller and spring. Even one roller gave a remarkable non-return effect. When jammed, it took a little effort with a small screwdriver to dislodge the roller from its wedged position, but when relaxed, the only force required was that needed to compress the roller spring. Continued pressure from the screwdriver forced the roller to the back of the tooth, then moved the ratchet — in the direction previously prevented by the jammed roller — the very action we were seeking. The germ of an idea formed... A home brewed four-tooth ratchet was hastily filed to shape; two right hand teeth and two left hand teeth, paired

on perpendicular axes.

As a try-out, two rollers were set in adjacent teeth, both forced forward into the wedge position by springs. Sure enough, the ratchet shaft jammed, refusing to budge in either direction.

Working like a charm

Pressed by a small screwdriver, first one roller and then the other was forced against its respective spring, whereupon the hybrid ratchet moved accordingly — just what had been hoped would happen. Fitted with all four rollers and driven by an inverted 'U' shaped driving yoke in place of the screwdriver, the rough little gubbins worked like a charm, moving freely when turned in either direction by the yoke, yet resisting all attempts to twist the ratchet shaft. A right little jeclanide.

The eventual outcome is shown in **Diagram B**. The cover is removed to show the non-rotating brake drum (Item 3), two of the four rollers (Item 7), the ratchet boss (Item 4), the two roller springs (Item 4A) and the hand operated driving yoke (Item 2).

In its relaxed state, the two springs force the rollers into close contact with both the ratchet and brake drum, locking them together as one. Turning the yoke in either direction forces the appropriate pair of rollers out of the wedge mode and allows the ratchet to rotate accordingly, the other roller pair trailing in 'free-wheel' fashion.

The driving yoke (Item 2) and the ratchet boss (Item 4) were made in that order from a reasonable length of trued 35mm bar stock, turned to 30mm dia. to within a few mm of its end face, leaving stock to form

the collar. The yoke was turned and bored then milled in the lathe to leave two lugs, each having a 56 degree included angle between faces, following which it was parted off to length.

The remaining piece of 30mm dia. stock was re-faced, centre drilled and then milled to form two flats, after which it was cross drilled to suit the springs. We salvaged springs from discarded ball pens but, in retrospect less bulky lighter-flint springs may have been a better choice.

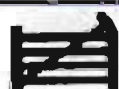
Once the drillings were completed, the four ratchet teeth were milled. We fixed the chuck at 30 degrees above and 30 degrees below horizontal and used an end mill, cutting two teeth at two settings, then repeated the manoeuvres for the opposite pair.

The remaining items are straight forward machining tasks, responding as always to accuracy and attention to detail.

For the Executive Toys, a support plate (Item 6) was fixed to a wooden base, long enough to provide accessible areas for clamping down.

With regard to the original application, a fractional degree of lost motion was of no concern from the instructor's point of view. However, as an experiment to satisfy our curiosity, one of the subsequent units had a solder layer added to each face of the yoke lugs in an effort to minimise lost motion. It proved highly effective and was noted for further reference.

If experience with the prototype is any indicator, your jeclanide will create much curious interest. It may lead to a duplicate in Perspex, if only to avoid the need for frequent dismantlings.



BLACKGATES ENGINEERING

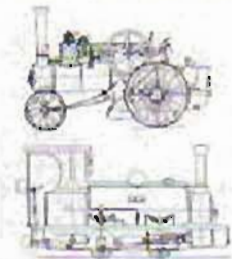
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3 1/2" 0-4-0 CHARLES HUNSLY FRAME STEEL TANK LOCOMOTIVE Starter kit includes: Drawings, frame steel, horns, axle boxes, driving & coupled wheels, axle pump, frame stretchers, eccentric sheaves, eccentric straps, cast smokebox. Starter kit £126.00 inc post and VAT.



MINNIE YELL 1" Scale Free-lance Traction Engine in "Model Engineer" 1960-70 by L.C. Mason. The finished model stands 11 1/4" high x 8 1/2" wide x 12" long and weighs approx. 28 lbs. All parts can be machined on a 3/8" lathe. The rear wheels being 4" dia. Drawings: Set of castings & gears flanged boiler kit construction book £290 inc. post & VAT. As above but with complete boiler (with test certificate) £478.00 inc. post & VAT.

LILLA 3 1/2" Gauge Hunslet 0-4-0 Constructors Loco designed by M.R. Harrison. Model of Hunslet Loco built in 1891 for Glynwryn Quarry, and later at Penryn Quarry. Described in "E.I.M." Volume No. 1 issue 3 to Vol. 2 issue 2. Starter kit for Rolling Chassis frame steel, wheels, cylinders, axle boxes, horns, axle pump etc & sheave, con rod mat etc. £189.00 inc post & VAT.

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SHOP OPEN TUESDAY, THURSDAY, FRIDAY & SATURDAY

The editor gets to grips with Emco's perennially popular Unimat – and uses it to make a couple of projects for this issue.

Having received an Emco Unimat PCBasic Lathe for review, the obvious approach was to use the machine for making small items of workshop equipment which could be featured as mini projects in MEW.

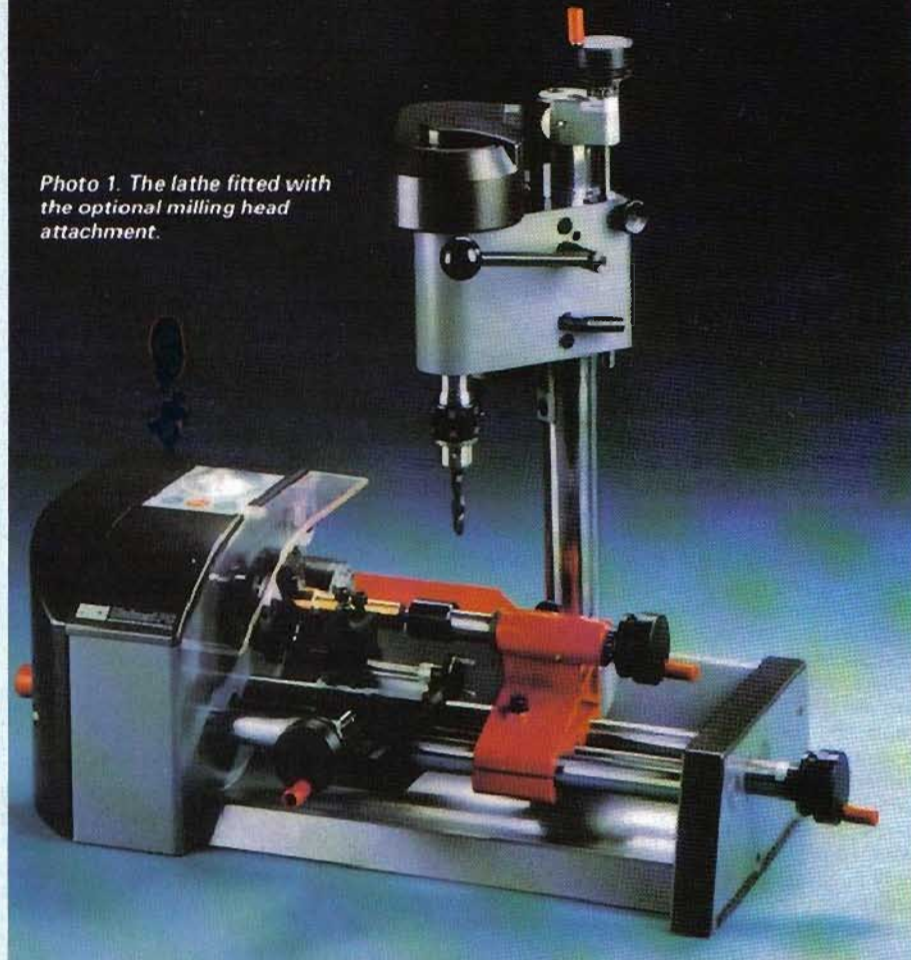
Three items have been made, these being a drill stand, a tapping aid and a marking gauge. The drill stand and tapping aid are in this issue, whilst the marking gauge will be published some time in the future.

The lathe is of unique construction being quite unlike any other that we are aware of. The main bed consists of two ground steel bars which are carried on a main frame of fabricated sheet steel construction. This may sound rather flimsy but the steel is of a heavy gauge and the result is very robust indeed. Its electronic speed control is another feature not to be found on many machines.

The basic equipment

The lathe comes with a range of accessories in addition to the basic lathe: These include a three jaw lever scroll chuck and a live tailstock centre. For screw cutting

Photo 1. The lathe fitted with the optional milling head attachment.



THE UNIMAT PC ASS

a quadrant with gears is supplied and, inherent in this arrangement, a fine feed facility. A tool post which will carry one tool only is mounted on the cross slide fitted with a replaceable insert toolholder. In addition there are numerous small items such as hexagon keys.



Photo 2. The recently introduced gear scroll three jaw chuck. This chuck is also suitable for fitting to earlier Unimat lathes.

Additional accessories

There is a wide range of additional items, too many to detail here, but the following are mentioned as they are commonly required and sometimes supplied as standard, particularly with larger lathes.

A top slide is available complete with built in three way tool post, that is to say it cannot be removed to permit fitting an alternative. A four jaw independent chuck is also available as is a geared scroll three jaw chuck (photo 2) – this item is a recent introduction and is compatible with earlier Unimat lathes.

The drill chuck listed as an accessory takes up to 8mm; this screws onto the tailstock rather than into a taper so has to be purchased from Emco.

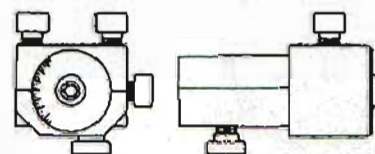
No centre is provided with the lathe for the headstock and if turning between centres is anticipated the special centre with driving arrangement will have to be purchased.

A face plate (though Emco call the four jaw chuck a face plate) is available; this differs from the norm in that it has tee slots rather than open slots (Emco call this a clamping plate). This item is seen mounted to the tailstock in photograph 3.

A major item is the vertical milling attachment (photo 1) which conforms largely in design to the add-on milling attachments available with other machines. The basic lathe has a very small cross slide table with a single tee slot and therefore a larger milling table is also available as an extra. This bolts direct to the cross slide and does not include its own slideways.

Another useful idea which may be available on other similar machines though we cannot recollect seeing it, is a support for mounting the milling table direct to the vertical milling attachment column. As we understand this, it would appear to create a small drilling machine facility which can

ACCESSORIES – MILLING



Adjustable swivelling device for all dovetailing work

Order No. 171200*

* – In preparation

then be used even whilst the lathe is set up for turning. The Emco description does not make this clear, as it is also vague about a device called an 'Adjustable swivelling device for all dovetail work' (see print from catalogue).

The remaining major items comprise: a fixed steady, but no travelling steady is listed, a collet system catering for sizes from 1 to 8mm, a simple dividing device fitted with a 24 way dividing disc with a set of three additional discs 30, 36, and 40 way. Finally, a Quick-change tool post for fitting onto the cross slide.

There are many other smaller items, far too many to list.

Electronic speed control

The speed control system is listed as an electronic control system with three mechanical transmissions. This means that the electronic control is only available over a limited range. This is then extended by the use of a toothed belt arrangement that

gives three ranges, which in total cover from 20 to 2200 r.p.m.

This unfortunately does not achieve totally what would be desired of an electronic variable speed system. It should be realized, though, that to adequately achieve a range of 20 to 2200 r.p.m. purely electronically would require a much larger motor to ensure sufficient power is available at the lower speeds. This would then also require an electronic controller with a higher output. Also to achieve lower speeds which would not vary with load to an unacceptable extent, would require a much more complex control system.

The system provided is therefore a very good compromise and works very well. Those who have not had experience of such variable speed drive systems will, we are sure, find it a very desirable feature.

One use we found for this, which worked very well, was when facing the end of a large piece of aluminium, to gradually increase the speed as the tool approached the centre. The drill stand featured in this issue is a typical example of where this method was employed. The three ranges are 20-300 r.p.m., 300-1200 r.p.m. and 1200-2200 r.p.m.

The milling head accessory is also fitted with a similar motor/toothed belt arrangement which plugs into the electronic controller fitted to the lathe to achieve the same speed ranges. This avoids the expense of a second electronic controller.

ASSESSED

Spindle nose sizes

All three positions where chucks and the like are fitted have the same fitting being M14 x 1. These are on the lathe mandrel, tailstock and milling machine attachment spindle. This permits such items as chucks, faceplates and drill chucks, etc., to be fitted in any position, increasing the flexibility of the machine in use. This can be seen in **photograph 3** where the drill chuck is fitted to the headstock and the faceplate to the tailstock.

The through bore in the lathe spindle is 10.2mm which is quite large for such a small machine.

Working ranges

The main dimensions which govern the size of work that can be undertaken are as

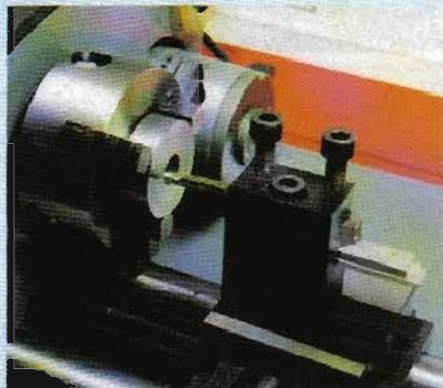


Photo 4. A typical machining operation using the new geared scroll three jaw chuck.

follows: Between centres 196mm, centre height 54mm and swing over cross slide 56mm. The traverse of the cross slide is 68mm and for the top slide, available as an extra, 40mm. The tailstock has a travel of 28mm.

Calibration

Movements for the saddle, cross slide and tailstock are all fitted with friction dials, these having divisions of 0.05mm. The divisions are broad and increments of 0.025 (about 1 thou.) are easily judged. The top slide has a fixed dial and is divided in 0.1mm increments.

In use

Having been used to a 3½ inch lathe it is easy to start the observations of the



Photo 3 Cross drilling a bar with the drill chuck mounted to the headstock and the faceplate to the tailstock

machine in use by comparing the Unimat with the larger machine. It obviously is unable to match the rate at which the larger machine can remove material from the workpiece and some may feel unhappy with this state of affairs. We are in no doubt, though, that an owner of say Harrison or a Colchester would feel the same about our Series Seven!

It is therefore only right to judge the lathe on that which it is reasonable to expect it to achieve. On this basis it would certainly be able to machine components up to the maximum size the lathe can take. It would, though, be necessary to set depth of cut and rate of feed in keeping with the size of machine and motor. With this precaution taken, work of a very demanding nature is perfectly possible.

The most physically demanding operation likely to be undertaken on most lathes is that of parting off which, unfortunately we were unable to try. However, a parting off blade and holder is on the list of accessories, so no doubt the machine is intended to perform this operation, but to what diameter is unknown...

The lathe should be able to match any other quality lathe in terms of finish and accuracy of work undertaken. With regard to durability, again this should be perfectly adequate, at least in the non-industrial environment.

Screw cutting

A quadrant, together with the necessary gears, is provided for all the most common thread pitches, and this assembly also included a fine feed facility which is brought into action by pulling a knob that projects out of the side of the gear cover.

Conclusions

To conclude, the machine performs very well and is well worth considering if a small lathe is to be purchased; the electronic variable speed system is a particularly nice feature.

We have only one very minor complaint which can easily be overcome. The top of the slot in both the tool post to go on the cross slide and that on the top slide is only about 2mm above centre height. If trying to

fit a tool which has been sharpened so that its cutting edge is greater than 2mm below the top of the shank, it is impossible to pack up the tool sufficiently. To overcome this some packing has to be placed below the toolpost itself (**photograph 4**). It would be easy to overcome this by widening the slot to permit tools to be raised to a higher level.

CAD/CAM

For those not aware of the meaning of the term CAD/CAM this is a Computer Aided Drawing/Computer Aided Manufacture. This permits a part to be drawn using a computer drawing facility, then for the part to be made on the appropriate machine with a limited amount of involvement by the operator.

The necessary attachments for adding this to the Unimat are available, though it is primarily intended as a training aid. A very brief review of this will be included in a later issue of MEW.

Wide range of machines

Emco Maier also supply a very wide range of lathes and other machines. For details of the Unimat and other products contact Emco Maier Ltd., 10 Woodshots Meadow, Croxley Centre, Watford, Herts, WD1 8YZ. Tel. 0923 250051.



John Jennings provides these simple devices to assist in achieving satisfactory blueing of screws and other small items.

The traditional finish of steel-work, such as screw-heads and hands on clocks and watches, is that described as a 'Blued finish'. This is obtained (leaving aside patent blue varnishes!) by forming an oxide film on the metal as we do when tempering tools, indeed the blue colour of springs on clock-work is due to tempering rather than cosmetic endeavours. Although well done 'blued' steel-work, which may vary from purple to dark blue, is very nice to look at, it has practical advantage that it adds a degree of rust proofing especially if quenched in oil. Blueing of screws etc might therefore enhance some of our home made tooling. Items to be blued need burnishing or polishing to a high finish and de-greasing before proceeding.

Many readers will know that tempering small items is tricky, it being easy to overshoot, and there are two traditional



A bottom view of the blueing tray and plate.

clock-maker's gadgets to ease the process: the blueing tray and the blueing plate. As well as enabling you to produce immaculate blued work, the tray in particular is useful for tempering small tools.

Blueing trays

The blueing tray consists of a brass (or steel) tray with a handle. In use it is filled with fine brass filings or turnings which even out the heat provided by a flame or hotplate. Complex shapes such as fretted hands can be nestled down into the filings and it may be the only way of blueing such items. The filings need to be clean and uncontaminated with other metals so you will need to clean up well before collecting them from a brass turning job.

Construction is straightforward, silver soldering the tray corners is optional if the specified material thickness is used.

The handle is somewhat experimental. I am not very keen on wooden handles for heated objects and the design shown should stay reasonably cool. They are developments of those shown in the photographs and hence differ in detail. The basic ideal is to reduce conduction from the tray or plate to the handle hence the three cross drilled holes. The PTFE rings, which

Top view of blueing plate. Note the handle-securing rivets.

Close-up of blueing plate showing three blued screws and two ready for treatment.

SCREW BLUEING TOOLS



Quick Tip

The other day I was in need of a face plate and, not having one, looked around for the possibility of making one. Then I discovered I had one ready-made. The 9in. round table from my Sealey pillar drill fitted the three jaw chuck – and was nicely balanced too.

Mr C.M. Mac.

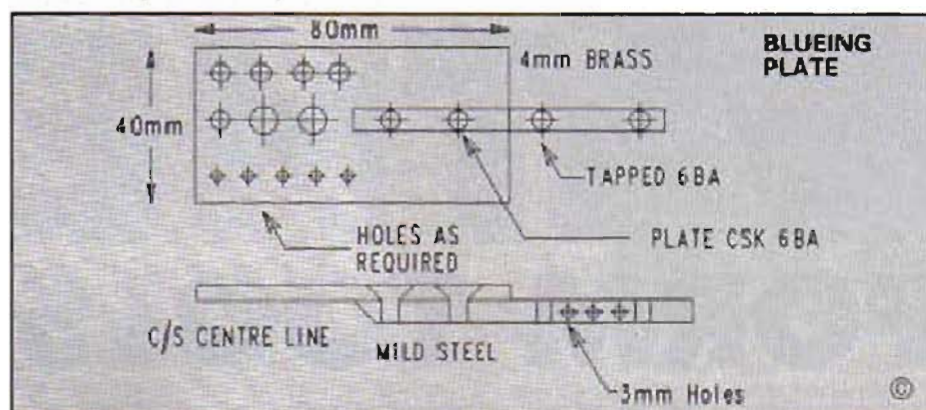
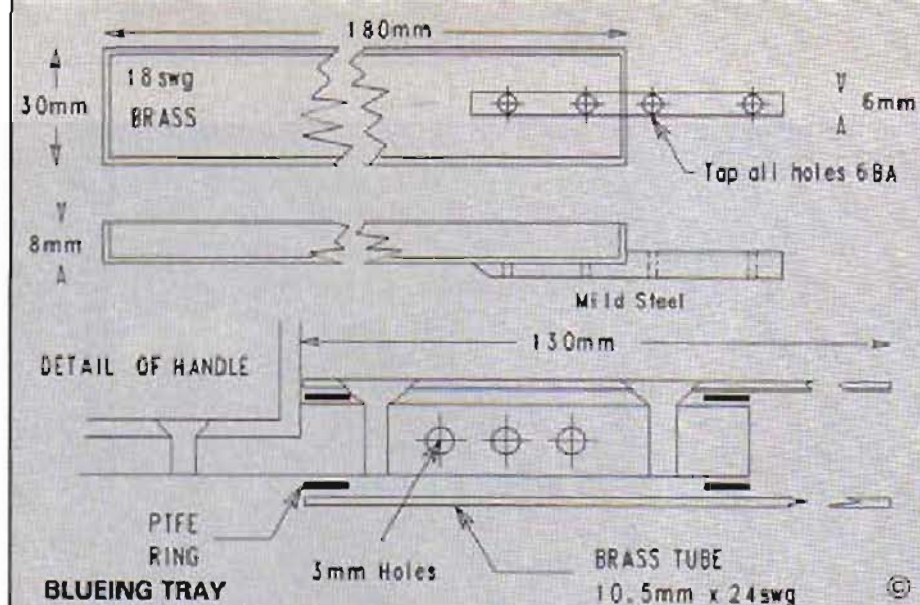


again reduce conduction and will resist heat, should fit inside the tube and allow easy entry of the steel inner. If you cannot obtain a scrap of rigid PTFE, plumber's tape wound round the steel bar would be a possible substitute.

Even with this design if you have a long session of blueing you will need to have an oven glove available.

Blueing plate

This is intended for blueing screws and similar objects. The construction is self-explanatory. The handle is essentially the same as that for the tray except that the steel strip is not stepped as for the tray. There being less need to lower the centre of gravity. Drill holes of size and number to suit your needs. In use the screws are dangled through the appropriate size hole and the plate heated, if all goes well they will blue at



the same rate and can be tipped into the quenching oil by inverting the plate. If some screws blue faster they can be picked off with a pair of tweezers (as of course you have to do with the blueing tray since you won't want to quench your brass filings in oil.)

Quick Tip

An easy formula for finding the tapping drill size for metric coarse threads is: Dia. of screw - Pitch
e.g. 10 - 1.5 = 8.5 drill

Alan Jeaves

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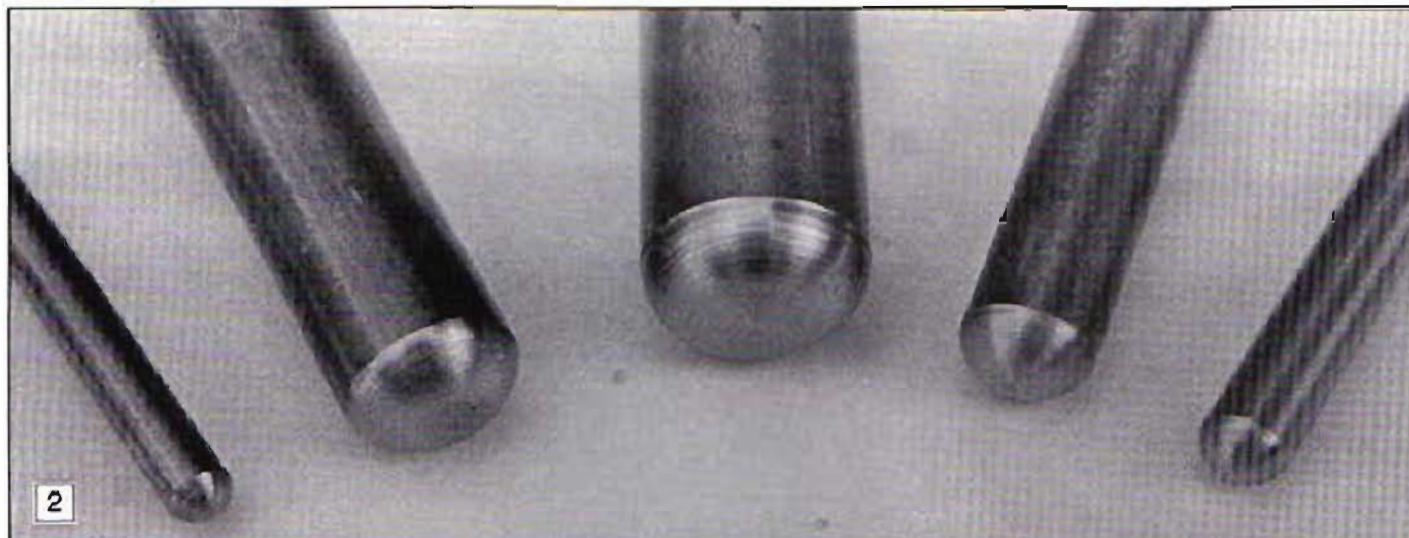
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2

In this article by the editor, the question of using form tools on the lathe is considered, this is a subject rarely discussed in books on using the lathe intended for the home machinist. As such, it offers very useful information



1

It recently occurred to me that although I had read many articles and books on the subject of lathe tools I could not remember having found them to include any discussion on the subject of form tools — except, of course, the common one of the thread forming tool.

A look through the books that I presently have available confirmed this situation. Admittedly there is not so much scope for form tools in the home machine shop as there is in the mass production environment, but those that are appropriate can be of considerable benefit.

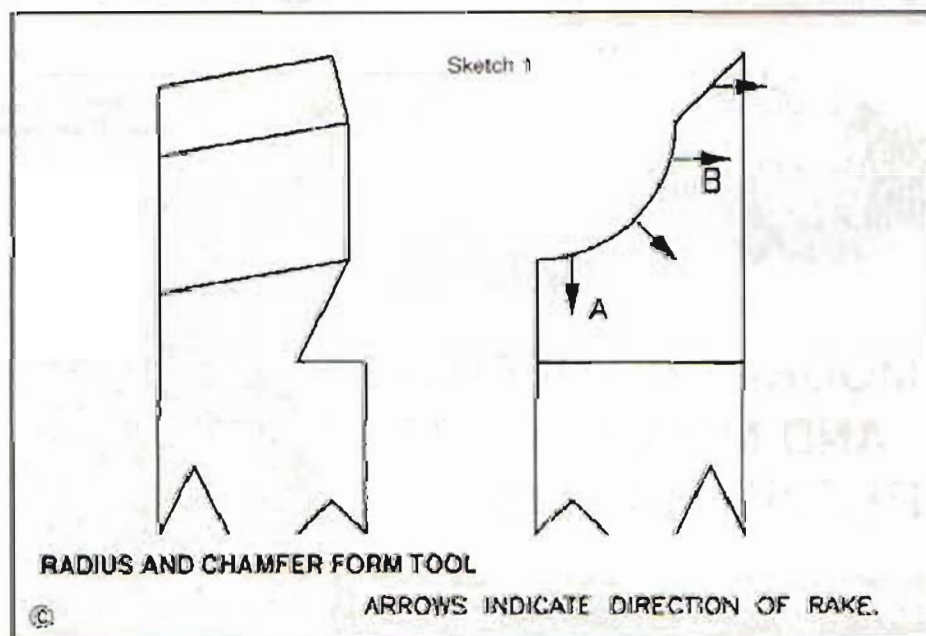
For those not familiar with the term 'form tool', it can be considered to be one which imparts its own special shape on the material being machined, by just feeding it to the work in one axis only. A single point thread forming tool is the only common example of this. With the tool traversed into the workpiece by the cross slide a vee shaped groove is produced with no assistance from the other axis.

What other form tool can then be of assistance in the home workshop? The range of possibilities is limited but they should not be overlooked. The use of these tools can be extended if we compromise on our definition of using a single axis only, and be prepared to deviate from this a little.

The external radius tool

Probably the most useful form tool is the radius tool. In the batch production workshop no doubt there would be a range

LATHE FORM TOOLS



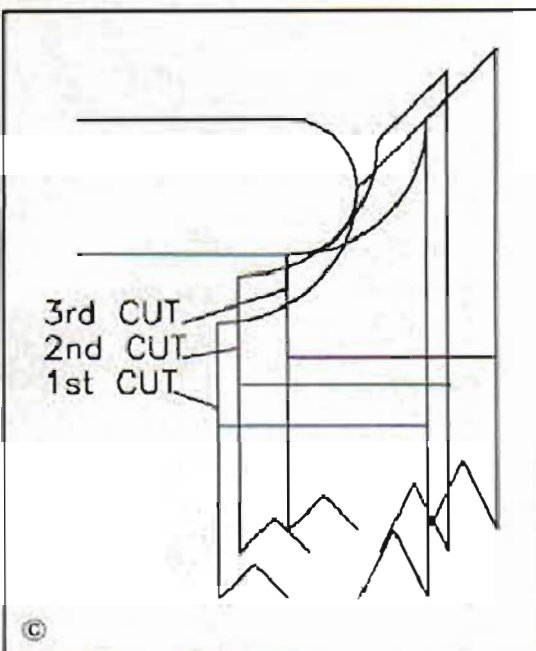
of tools each one to create a specific radius, say one for $\frac{1}{8}$ inch, one for $\frac{3}{16}$ inch and so on.

Sketch 1 and photograph 1 show the form a radius tool would take, and if applied to the workpiece using one leadscrew only it would produce just that one radius. By repeated application of the tool in slightly different positions, as shown in sketch 2, a smaller radius can be obtained. For clarity the sketch shows the tool being used in only three positions; in practice many more would be used and a radius obtained which would show no evidence that it had been made in this way.

The parts with a range of radii as seen in

photograph 2 were deliberately made rather rapidly by this method. All used the same tool and without any attempt to clean up the result using a fine file or emery paper. I think it can be seen from the photograph that presentable results have been achieved.

The procedure would be to have the tool set at maximum diameter and for it to approach the workpiece using the saddle until the tool was cutting completely to the centre of the work. When this is achieved the tool would be moved away using the saddle and then moved a few thou. closer to the centre using the cross slide. A further cut then taken using a saddle, but this time



PRODUCING A SMALLER RADIUS BY USING THE TOOL IN DIFFERING POSITIONS

Sketch 2

leaving just a little of the initial radius intact. This process is repeated until the desired radius is arrived at.

By this means a radius much smaller than that to which the tool has been made can be achieved. The photograph shows a range of from $\frac{1}{8}$ inch down to $\frac{1}{16}$ inch obtained using the same tool, and still smaller could be achieved easily.

If a full radius is required — that is one which is made up to the centre of the material to create a half sphere — then the maximum size will be that to which the tool has been made. There is no reason though why, say, a $1\frac{1}{2}$ inch radius cannot be turned onto a larger bar than the $\frac{1}{2}$ inch size which would give a full half sphere on its end.

The chamfer tool

Another form is the chamfer tool; this can be used to produce a range of sizes, from just removing the sharp edge and being hardly visible, up to the width the tool has been made. By repeated use in the differing positions a larger chamfer can also be produced. In this case the line between the two cuts will be more difficult to hide, compared to the multiple use of the radius tool. The result of using a chamfer tool is shown in **photograph 3**.

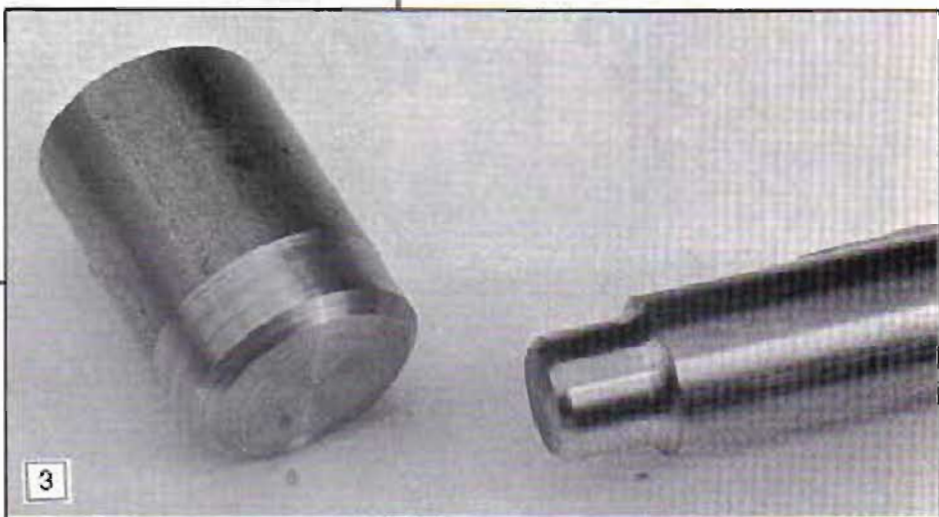
The slot cutting tool

Yet another type of form tool and one for which there is no alternative (both a chamfer and a radius can be produced by other means) is the tool for producing grooves. A typical requirement for this would be to house a circlip. This requires little explanation being as a parting off tool but with a flat end.

The internal radius tool

One type of tool which does appear in articles relating to lathe tools and can be considered a form tool, even though it is not listed with this in mind, is the round nose or, as I think I remember it being referred to, the 'bull nose' tool. This is used by many as a means of obtaining a good finish if very light cuts of a few tenths of a thou. are taken, and yet is also capable of being used for quite heavy cuts.

This tool is also useful for producing an internal radius, and similarly to the external radius tool can be used to produce radii over a range of sizes.



Making the combined radius and chamfer tool

Let's return now to probably the most generally useful form tool, the external radius tool. Close examination of that proposed in **sketch 1** and **photograph 1** will show that it has been arranged to include a chamfer tool. If considered sufficiently useful, this need now only take up one position in the four way tool post.

Making the tool does require a little skill and the following approach will probably be the most easy for those who have to create this by hand, as opposed to using a cutter grinder. A round oil stone of the same radius or, if not available, a smaller radius will also be beneficial.

First grind the radius including at the same time the required side clearance. If the chamfer section is to be included then create radius with about an extra $\frac{1}{8}$ inch available at the front end, use a piece round material of the correct diameter as a gauge.

With the radius completed satisfactorily the top rake has to be added. Now ideally

the cutting edge, at least for the radius section, should be at centre height around its complete length. This will not be easy to achieve precisely, but the following method should enable a reasonably acceptable result to be obtained.

Start by grinding the top rake from front to back as indicated by arrow A. Grind this as a flat — make no attempt to include any curvature at this stage. Follow this by including top rake from side to side as indicated by arrow B. At this stage we now

have top rake in the form of two flats.

It should now be relatively easy to create a continuous top rake around the radius cutting edge by blending these two flats together. A useful method of acquiring the correct wrist action is to make a dummy radius tool. Make this from a piece of 1 inch square wood using a file finally to get the approximate shape. This can then be held against some rigid object and moved such that it remains in contact around the cutting edge, the required motion to achieve this being observed. Practice this until confident to produce the actual radius tool itself.

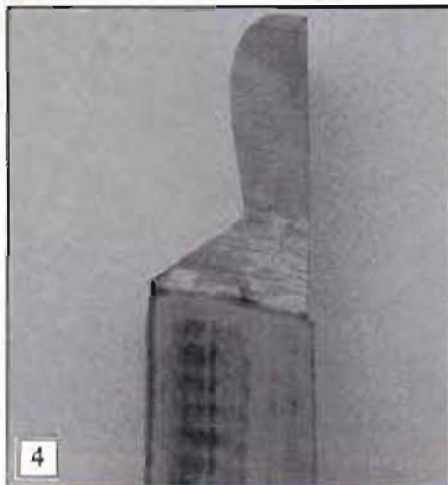
Having completed the radius it is simple now to produce the chamfer portion. In view of the rake already present for the radius part of the tool, the cutting edge will not be level, but this, whilst not being as per the book, works quite satisfactorily.

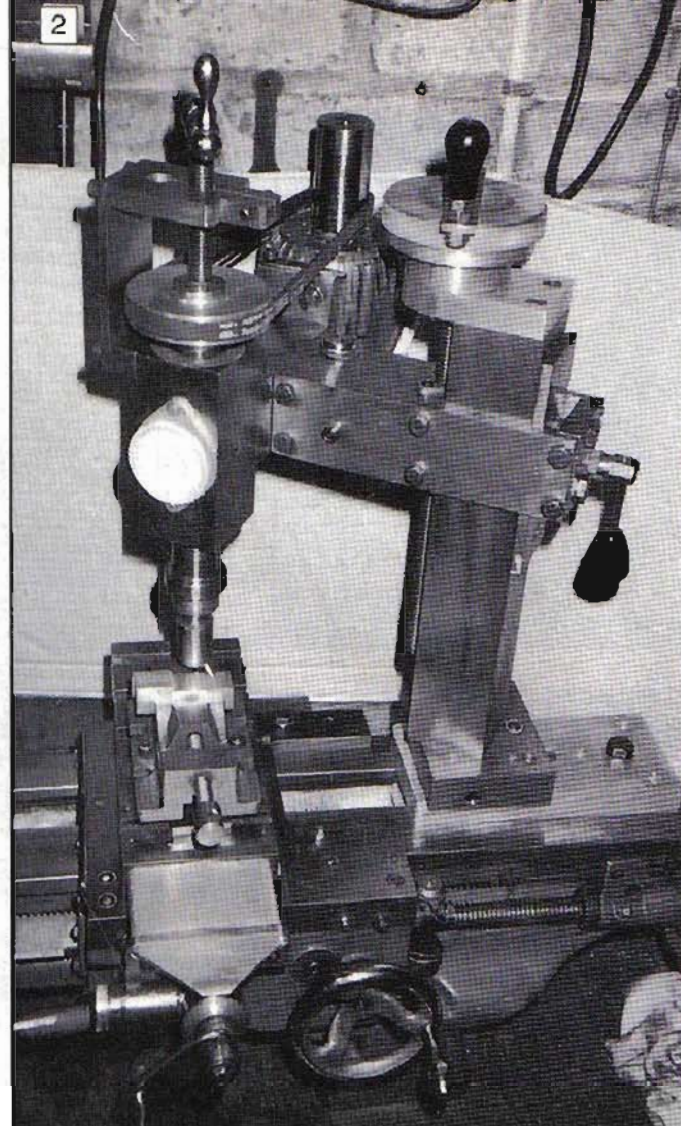
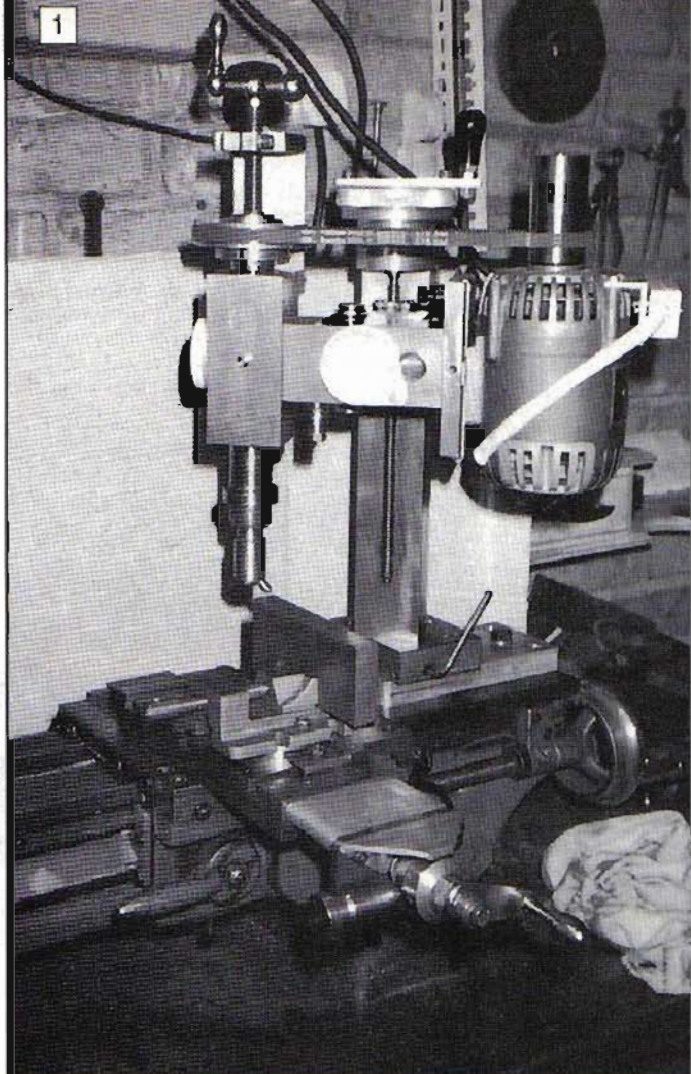
Repetitive operations, whilst being less frequent in the home workshop, do result sometimes — maybe a large number of rivets to be made. In which case a purpose made radius tool should be considered, for not only will it improve productivity, but will also result in a more consistent and better quality end product.

Making the combined facing and chamfer tool

Another tool worth considering if parts are to be made in batches is the combined face and chamfer tool; this is shown in **photograph 4**. Using this tool will achieve a good finish to the end of the bar being faced, and will also be able to create a chamfer. The chamfer can be from just a deburr to as wide as the tool will permit.

The distance from the curved surface to the chamfer will govern the maximum diameter the tool will work with. If a smaller diameter is being faced the tool should preferably be moved away from the face as it passes the centre, to avoid rubbing.





1&2: The machine set-up in the vertical milling mode, the unit is mounted on the lathe bed, with the workpiece on the cross slide

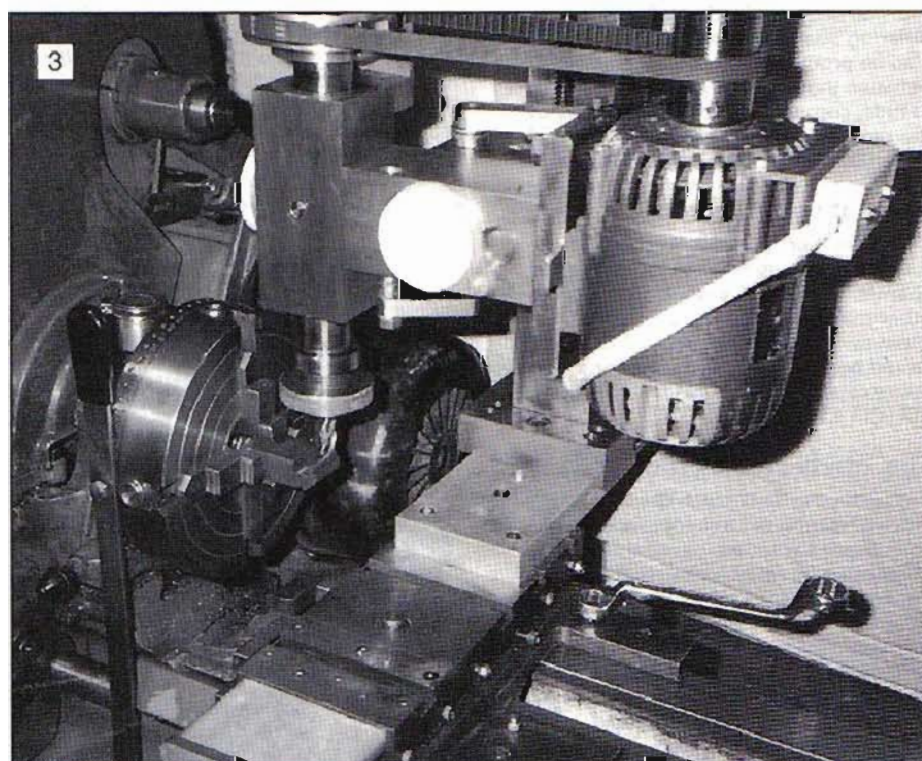
UNIVERSAL MILL

This excellent lathe-mounted milling attachment is provided by A. Longworth; it should satisfy the many readers who have requested such an item, but if too large, it should be relatively easy to scale it down. If too complex there should be scope for some simplification

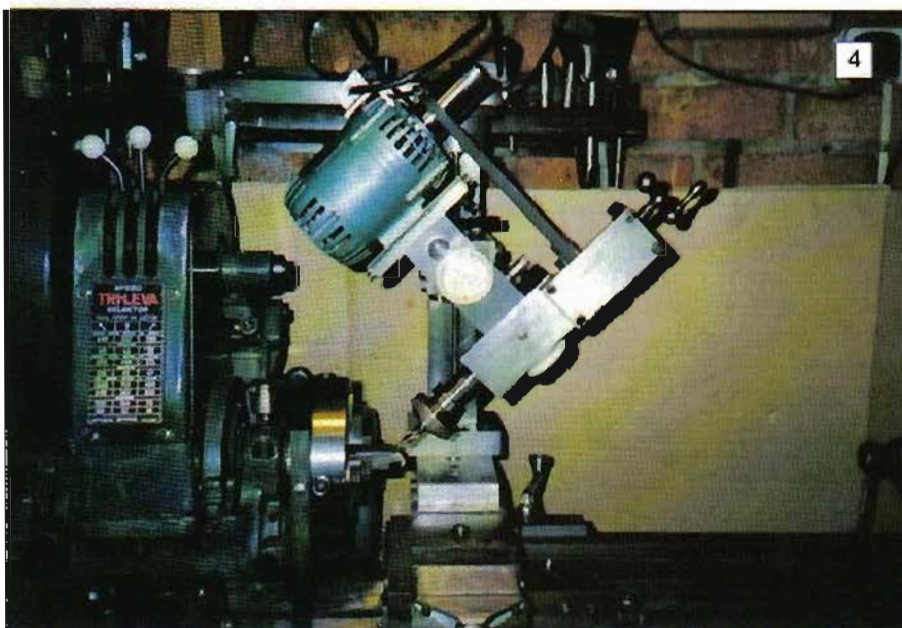
The term universal is used to describe the fact that the unit can be mounted either on the lathe bed, thereby utilising the saddle and cross-slide of the lathe as the milling table, or on the cross-slide, thereby enabling work positioned in the chuck or on the faceplate to be machined. The milling head can be set at any position from vertical to horizontal and rotated fully on its vertical axis, giving a wide range of settings.

The unit is proportioned to the Myford ML7 series but the design could be modified to suit other lathes by adjusting the column foot to suit the particular lathe. The mandrel nose is based on the Myford 7 series but could be changed to suit individual requirements.

The motor specified is a $\frac{1}{8}$ th HP shunt wound DC unit, 125 watt output at 4,000 r.p.m., made by Parvalux. Speed control is



3: The unit mounted on the cross slide and being used to machine a component located in the lathe chuck.

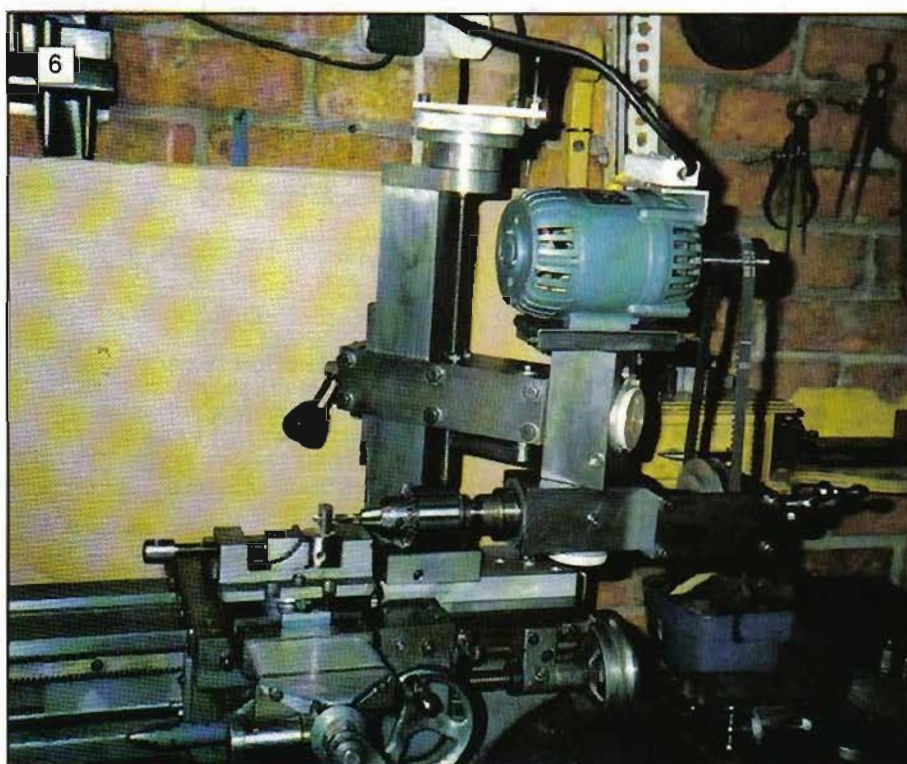


4 & 5: A similar set-up to the previous group, this time with the machine used for angle milling.

by variable resistance in the line via a semi-conductor rectifier. More sophisticated thyristor controllers are available from Parvalux but these are not cheap. The motor speed is reduced to half by pulleys, with further reduction by the control. The belt drive used is a toothed timing belt although the pulleys are plain. This type of belt gives very good traction without need for excessive tension, but will allow for slip in case of accident such as insufficient clamping either of the workpiece or the milling head. These mishaps occur even in the best-run workshops. The ability to slip can limit damage to both the workpiece and the milling cutter.



ING ATTACHMENT



6: Another use for the machine, seen here set-up for horizontal milling.

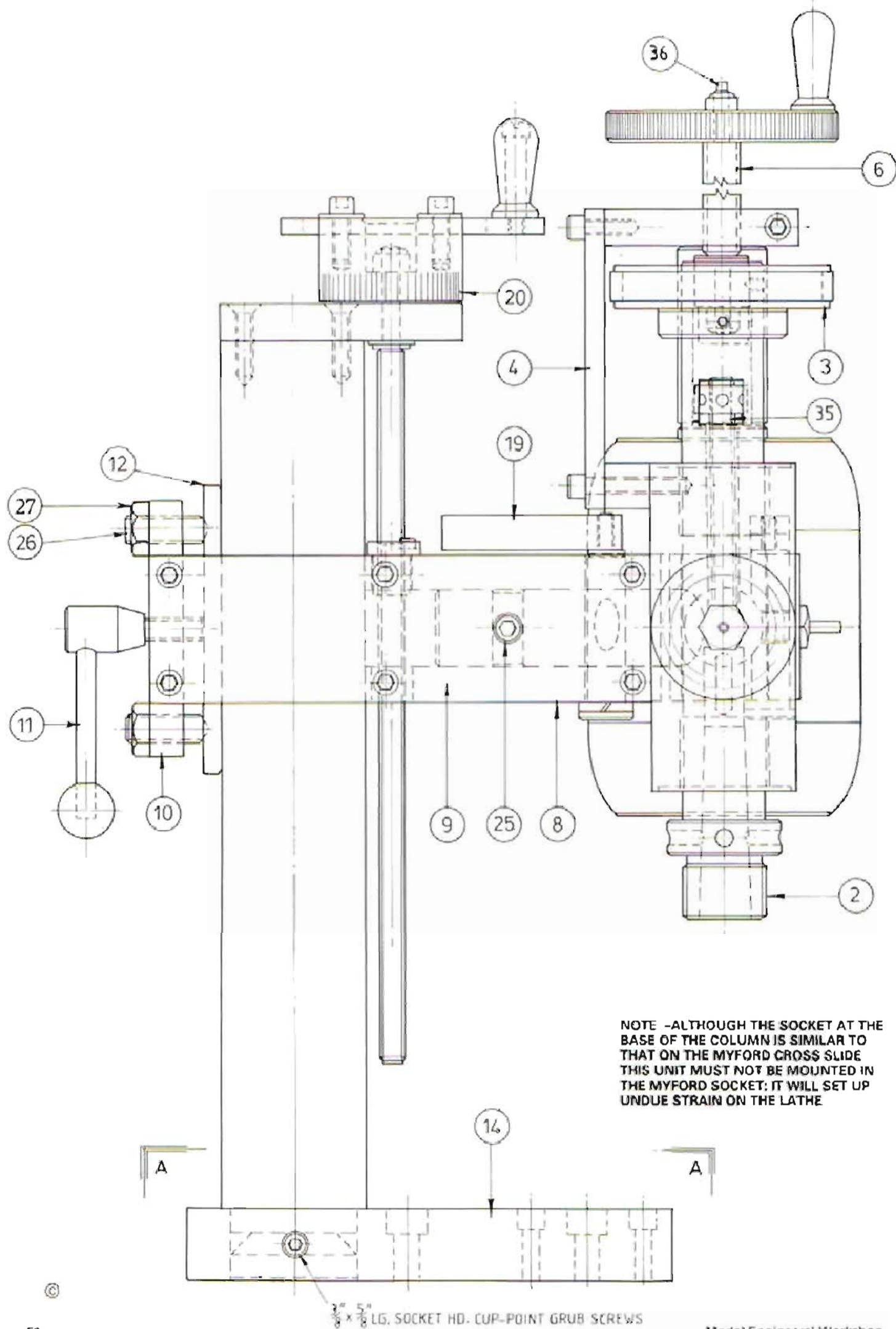
surface by using fine wet and dry paper and fine oil.

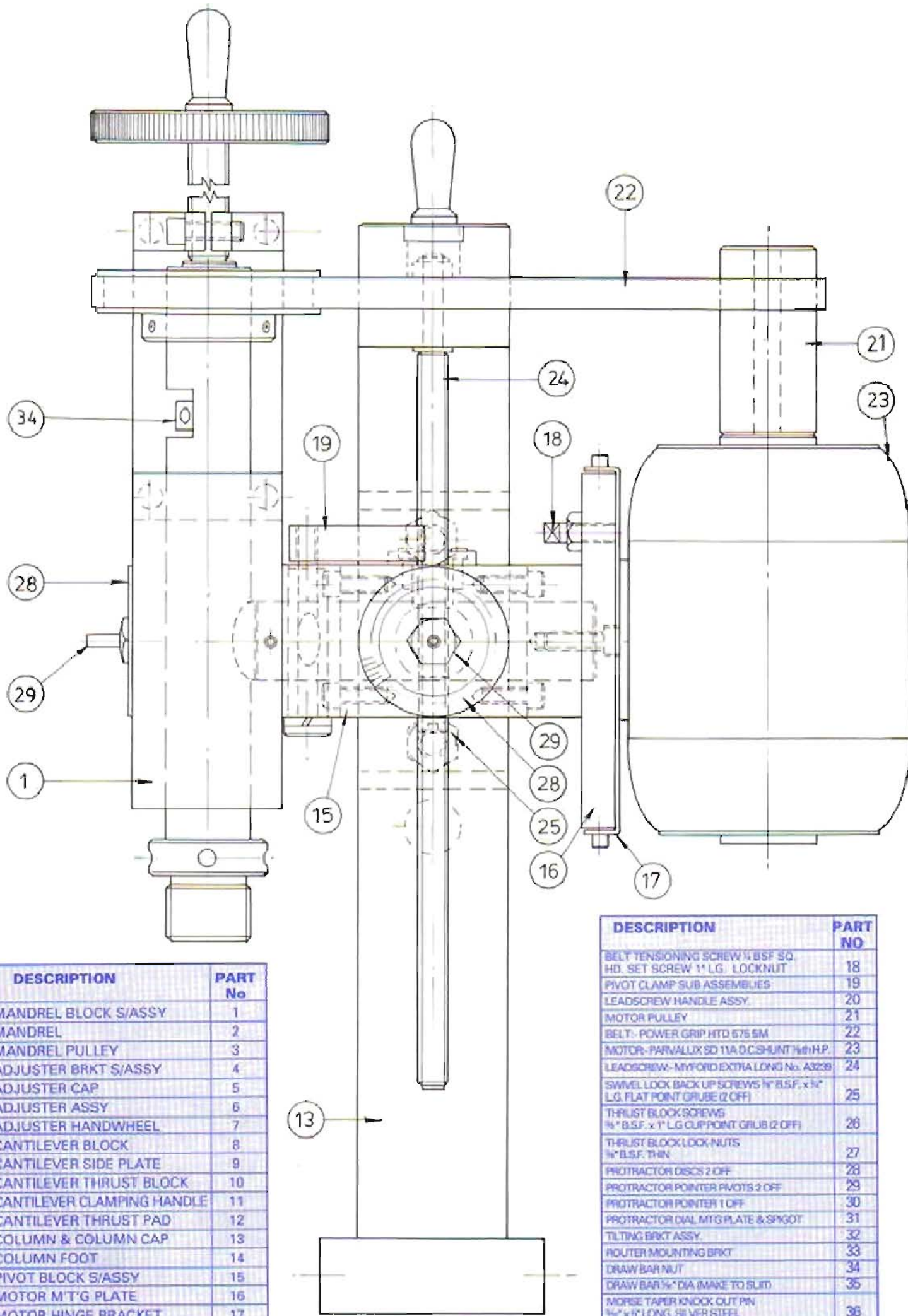
'Glacier' bearings, though designed to operate dry, benefit from lubrication especially during running-in. Light machine oil is ideal for this and a few drops applied before use will extend their lifespan considerably.

The main structure utilises standard 2in. square BMS stock which, ideally, would be surface ground on all four faces but, if this facility is unavailable, a satisfactory finish can be achieved by applying an "Arkansas" stone, preferably a new one, in a planing action on all faces prior to sawing to size. Use plenty of oil and the course side first, followed by the fine side. Similarly, the face of the thrust pad (see Part 12) should be smoothed as flat as possible and polished. In addition, an excess of elbow grease will be required!

The assembly of the pivot block Sub/assy (see Part 15) and the mandrel block Sub/assy (see Part 1), i.e. blocks to pivot bars, can be by means of grubscrews engaging in 'V' grooves in the bars or by being pinned through. Additional security can be provided by applying Loctite to the bars before assembly.

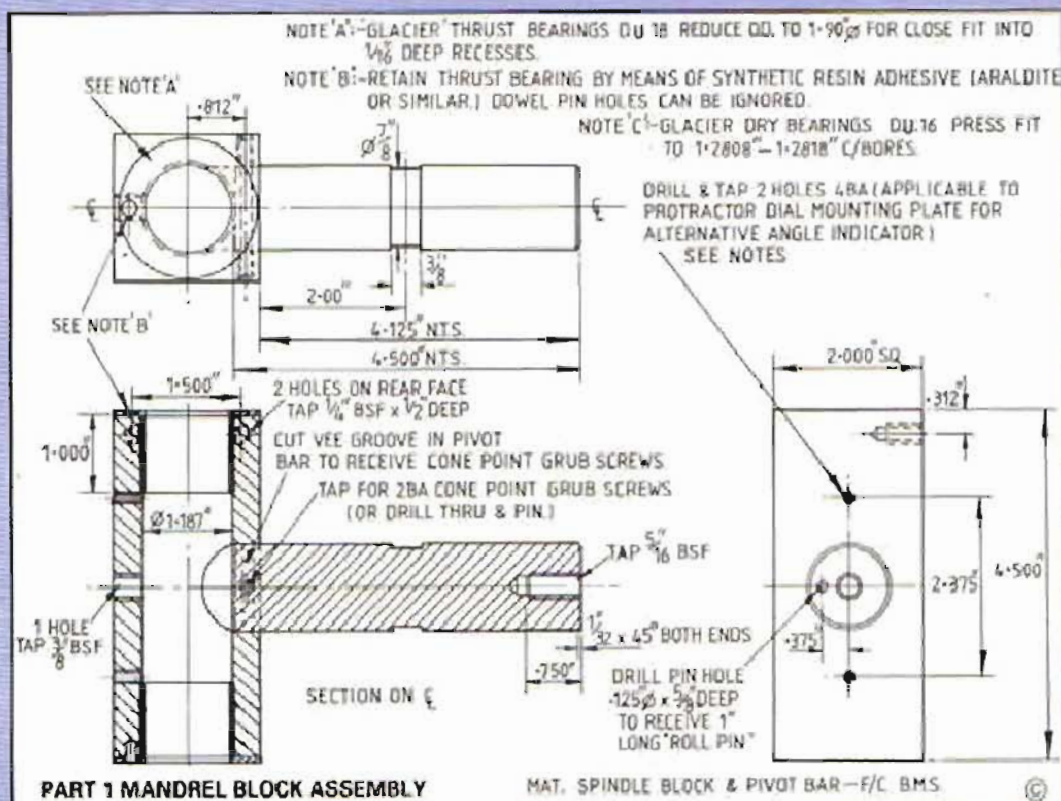
The leadscrew used on the prototype is the Myford extra long No.A3239, with the standard nut fitted into the cantilever block (see Part 8).

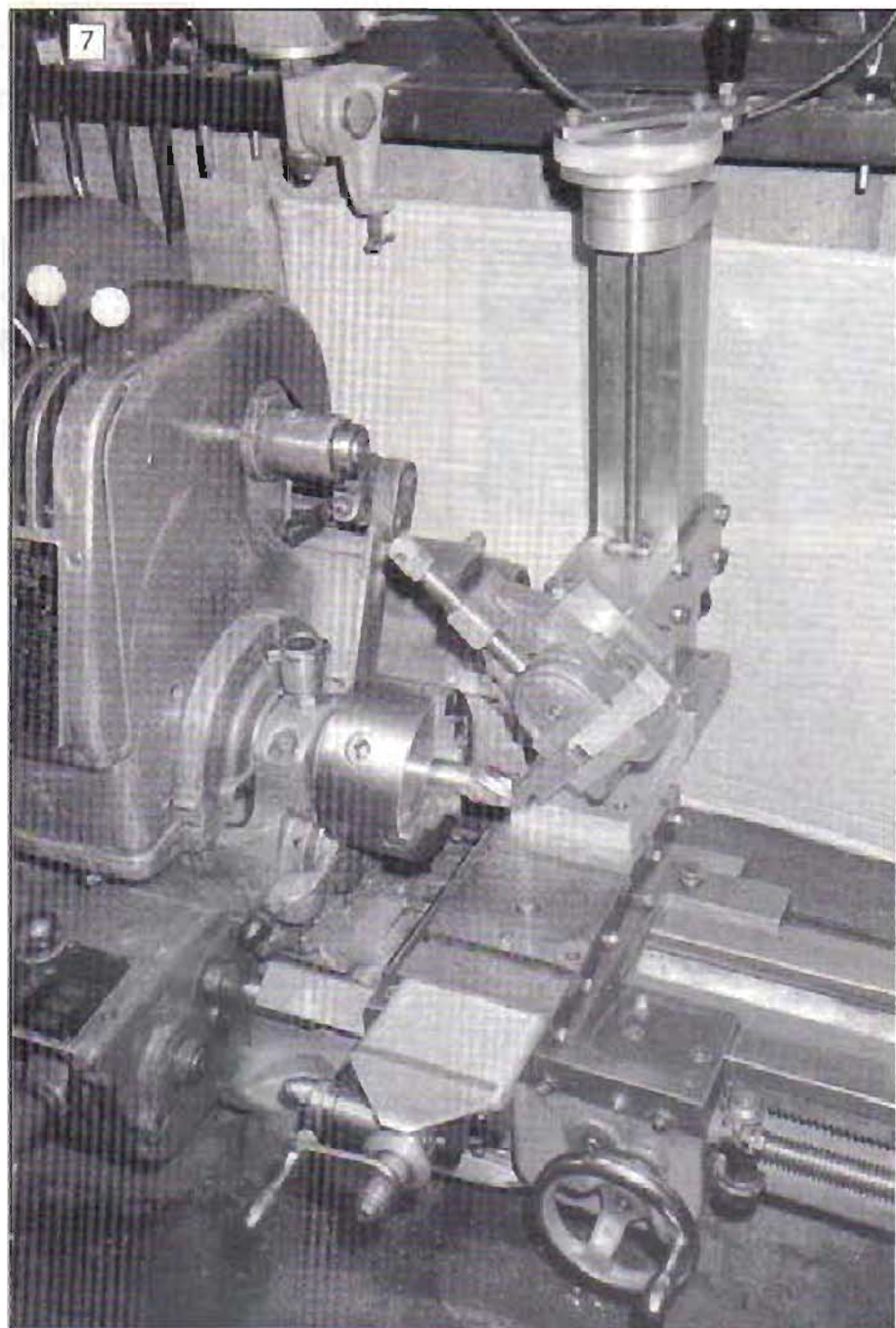




DESCRIPTION	PART No
MANDREL BLOCK S/ASSY	1
MANDREL	2
MANDREL PULLEY	3
ADJUSTER BRKT S/ASSY	4
ADJUSTER CAP	5
ADJUSTER ASSY	6
ADJUSTER HANDWHEEL	7
CANTILEVER BLOCK	8
CANTILEVER SIDE PLATE	9
CANTILEVER THRUST BLOCK	10
CANTILEVER CLAMPING HANDLE	11
CANTILEVER THRUST PAD	12
COLUMN & COLUMN CAP	13
COLUMN FOOT	14
PIVOT BLOCK S/ASSY	15
MOTOR M'T'G PLATE	16
MOTOR HINGE BRACKET	17

DESCRIPTION	PART NO
BELT TENSIONING SCREW 1/4 BSF SQ. HD. SET SCREW 1" LG. LOCKNUT	18
PIVOT CLAMP SUB ASSEMBLIES	19
LEADSCREW HANDLE ASSY.	20
MOTOR PULLEY	21
BELT- POWER GRIP HTD 575 SM	22
MOTOR- PARVALUX SD 11A D.C. SHUNT 1/40 H.P.	23
LEADSCREW- MUYFORD EXTRA LONG No. A3238	24
SWIVEL LOCK BACK UP SCREWS 1/4" B.S.F. x 1/2" LG. FLAT POINT GRUBS (2 OFF)	25
THRUST BLOCK SCREWS 1/4" B.S.F. x 1" LG. CLIP POINT GRUB (2 OFF)	26
THRUST BLOCK LOCK-NUTS 1/4" B.S.F. THIN	27
PROTRACTOR DISCS 2 OFF	28
PROTRACTOR POINTER PIVOTS 2 OFF	29
PROTRACTOR POINTER 1 OFF	30
PROTRACTOR DIAL MT'G PLATE & SPIGOT	31
TILTING BRKT ASSY.	32
ROUTER MOUNTING BRKT	33
DRAW BAR NUT	34
DRAW BAR 3/4" DIA (MAKE TO SUIT)	35
MORSE TAPER KNOCK OUT PIN 1/2" x 5" LONG, SILVER STEEL	36





7 & 8: Versatility indeed, here the motor unit is removed. The cutter is mounted in the lathe chuck, and the unit is being used as a vertical slide.

Mounting the unit onto the cross-slide is achieved by means of 3 standard "Tee" nuts fitted to the rear two slots in the cross-slide. Mounting the unit to the lathe bed is achieved by clamping the column foot (see Part 14) to the bed by means of the clamping plate (Part 14). In either position, assembly is easier if the foot is fitted first to either the cross-slide or the lathe bed. In the latter position, the foot is situated with the column socket towards the head-stock and, before tightening the clamping screws, the carriage should be traversed to the right to position the cut-out in the saddle around the foot in order that it does not interfere, and then tighten the set screws. It is now easier to mount the unit to the foot, rotate to the desired position and tighten the grub screws to lock the column.

Angular setting of the milling head is aided by means of two protractor discs and pivoted pointers (see Parts 28, 29 & 30).

One disc is mounted on the pivot block Sub/assy (see Part 15) and the other is mounted on the mandrel block (Part 11).

Compound or simple angles of the head can be set, as can either vertical or horizontal settings.

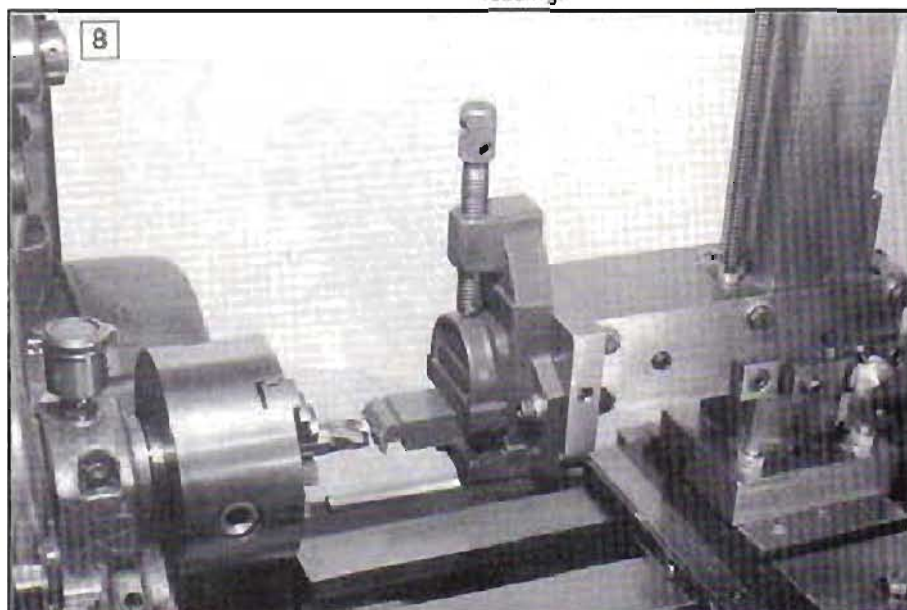
To set the head, the clamp in either the cantilever block or in the pivot block is slackened and either the mandrel block tilted to the angle indicated by the pointer, or the whole head swivelled to the angle indicated on the disc mounted on the pivot block. The appropriate clamp is reapplied and the angle indicator checked; if correct, the back-up locking grub screw should now be tightened. After the whole milling head is lowered to the cutting position, the cantilever clamp (see part 11) is applied.

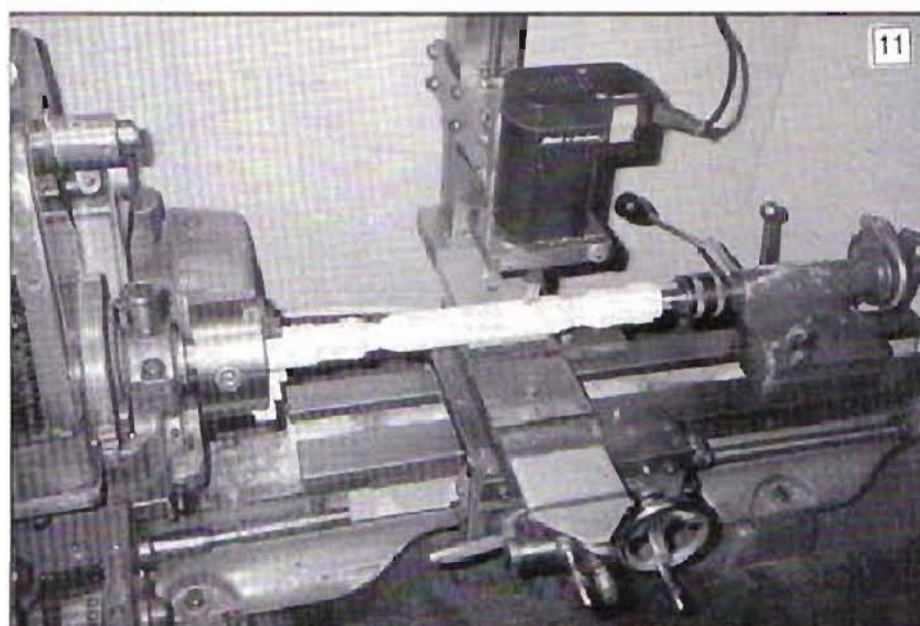
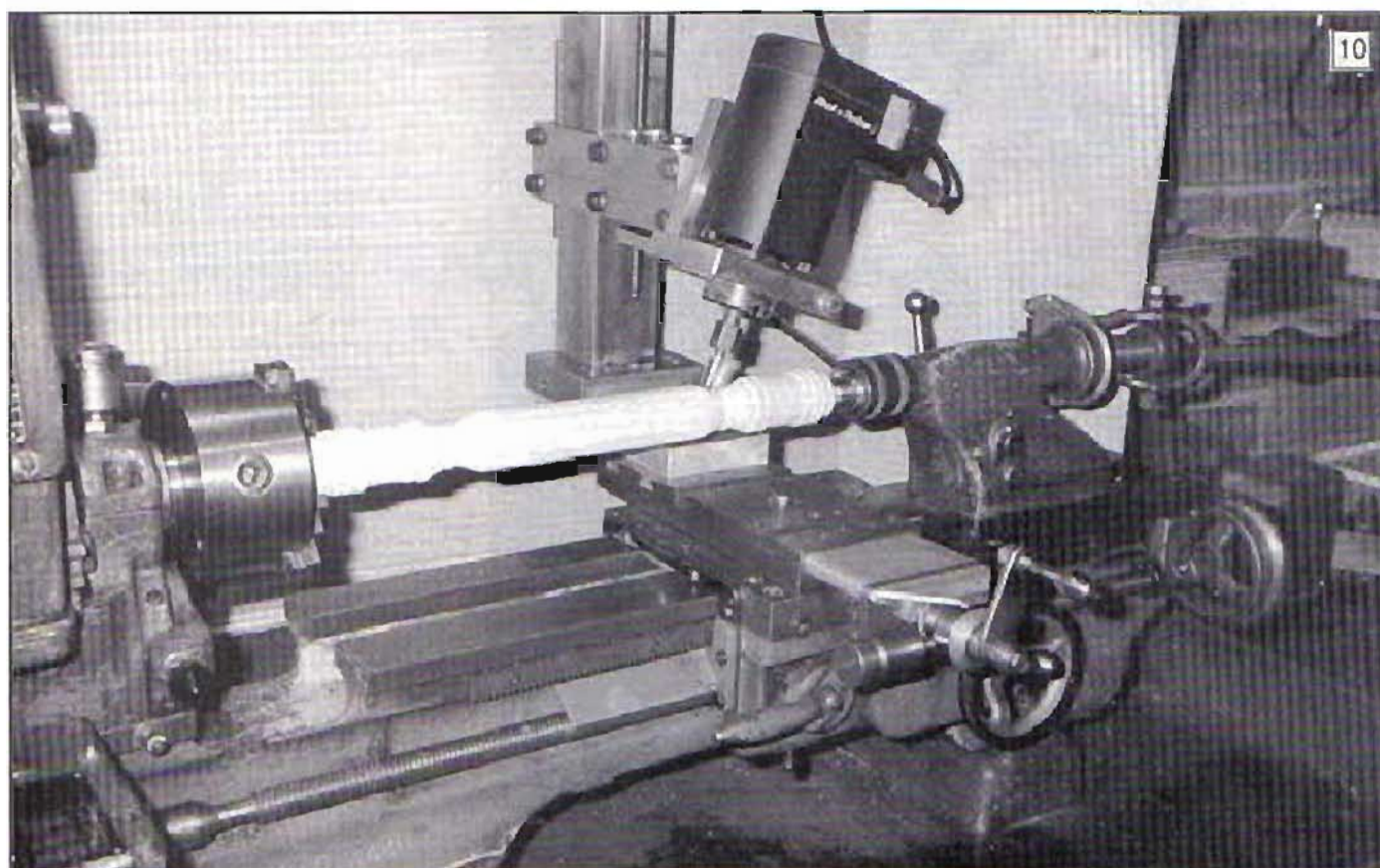
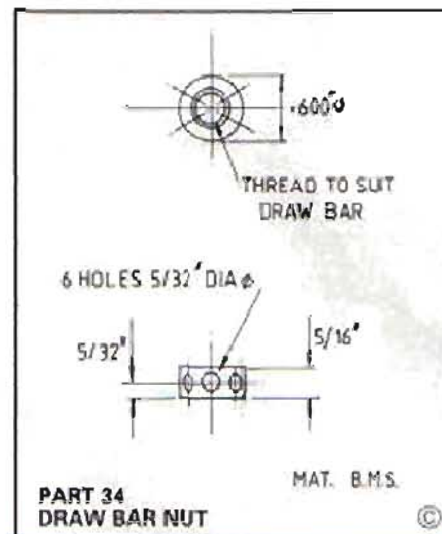
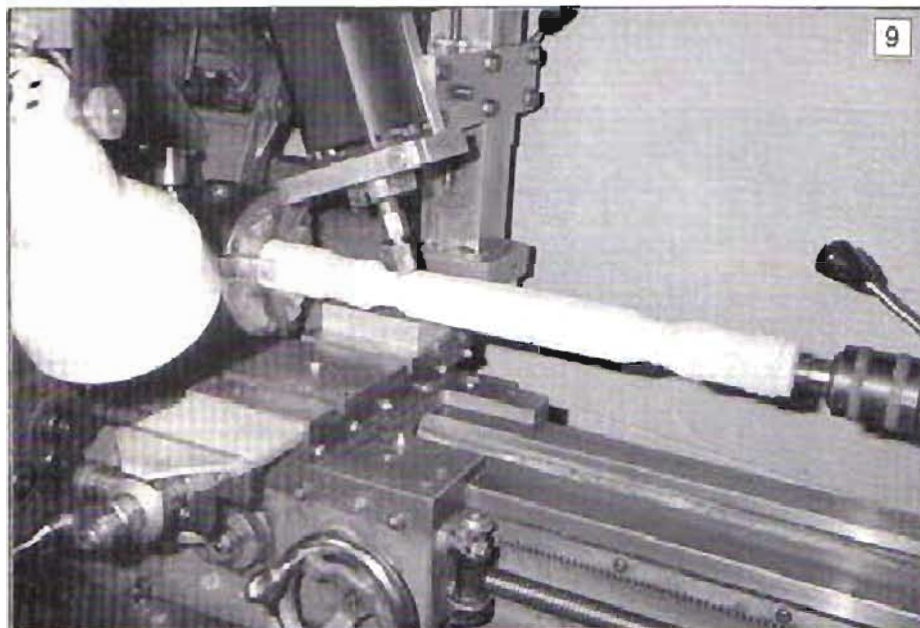
Once the head has been set, the pivoted pointer can be removed and slipped into one's pocket until required again.

To set the head horizontally, it is necessary to release the cantilever clamp (Part 11) and raise the whole head high enough to allow the head to rotate.

The mandrel block should first be rotated to bring the mandrel nose uppermost. The clamp in the cantilever block (see Part 8) is now released to allow the whole head to be rotated until the milling head is horizontal. True setting of the horizontal is checked by means of the pointer as before. The head can now be raised to the required height. Always remember to apply the back-up locking grub screws and the cantilever clamp before commencing a cut.

An alternative to the protractor discs and pointer method of angular setting (and somewhat easier to achieve) is illustrated on Part 31. It comprises of two neat protractor dials (obtainable from O. Fisher Ltd., Broadstairs) which are simply assembled to mounting plates which allow for adjustment to obtain accurate setting. To determine true setting of the head, a piece of ground stock or drill blank is gripped in the appropriate collet and, using an engineer's square resting on the lathe bed, the head is adjusted to give accurate alignment of the rod to the square, taking two sightings 90° to each other. The head is now locked and the protractor dials set to give alignment of the pointers to the zero marks. The protractor dials are divided into four 0-90° segments which is ideal for easy reading.





9 - 11: Another use for the tool, here the basic machine is fitted with a router and being used for producing complex components in wood.

Suppliers

Motor

Parvalux Electric Motors Ltd., Wallisdown, Bournemouth, Dorset BH11 8PU or Harrison Electrical, 17 Chigwell Road, South Woodford, London, E18

Bearings

Glacier Metal Co Ltd., Riccarton, Kilmarnock, Strathclyde KA1 3NA
Drive belt
Davall Gears Ltd., Welham Green, Hatfield, Herts. AL9 7JB

Metals

GLR Distribution Ltd., Great Northern Works, Hartham Lane, Hertford SG14 1QN

Dial Protractor

O. Fisher Ltd., Dyson's Road Industrial Estate, Broadstairs, Kent (May not supply small quantities)



A selection of straight 'D' bits used for reaming.

In the article on drills and drilling in the June/July '92 issue, Mr Loader stated that the drill was an unsatisfactory tool for producing reliably accurate holes. He explained that a reamer was the method to use for accurate holes and in this article he discusses their use — plus the useful and quite good alternative, the home-made "D" bit

Making a hole in something is no problem to an engineer; making the hole accurate and with a good finish is quite another proposition. As I mentioned in a previous article, drills aren't designed with high finish or accuracy in mind. The tool to use is, of course, a reamer.

Reamers have been around for a long time. In a publication of 1864 there is a reference to a tool, 'used to enlarge the hole made by the bit'. In 1881, *Metal World* had, 'bore the tang hole with a gimlet and slightly ream the hole with a taper reamer'. Both these examples sound rather primitive, until the date is thought about. Time, however, always improves technology and in 1909 there is evidence that reamers were used much as we would, from a contemporary magazine. The statement, 'Two bolts... engage in two carefully reamed holes in the pivot and lever...'

Enough of their history, they do a useful job and save lots of time. There are lots of different sorts, but the ones we are most concerned with are just two, hand and machine. The main difference is easy to spot and the clue is in the shank. A machine reamer will have a Morse taper shank to fit a machine spindle; a hand one will have a square on the end of the shank so that it can be used by hand. It doesn't

REAMERS AND REAMING

mean, of course, that a hand reamer *must* be used by hand with a wrench. In fact the best results are from using it in a machine, but it is sometimes an advantage to be able to use it by hand.

The other difference is in the cutting flutes. A machine reamer cuts full diameter all the way, except for a short lead of 45 degrees to give the cutting edges a start. A hand reamer has a slight taper for about 1/4 to 1/2 of its length, a very useful taper for some jobs, more about that later.

Like other cutting tools, reamers can be made from several different materials, high speed steel ones being the best, but carbon steel ones are cheaper and will give good service, because they are used at slow speeds and rarely get hot, heat resistance being the reason for preferring HSS. By far the cheapest option is to make your own reamers, which I'll come to later. The most expensive are those with tungsten carbide inserts, well out of pocket range for most home machinists!

Like drills, reamers will be stamped, engraved or etched on the shank with the material, if there is nothing assume that they are carbon steel. If in doubt, do the spark test on a grinding wheel, very carefully where it doesn't matter, on the rear end of the shank.

In the smaller sizes, reamers will have 6 flutes, the very small ones 4 and the very large ones 8 or more. The flutes are shallower than drill flutes because they have less cutting to do and need less room for swarf too. The cross sectional shape is stronger than a drill, see Fig. 1.

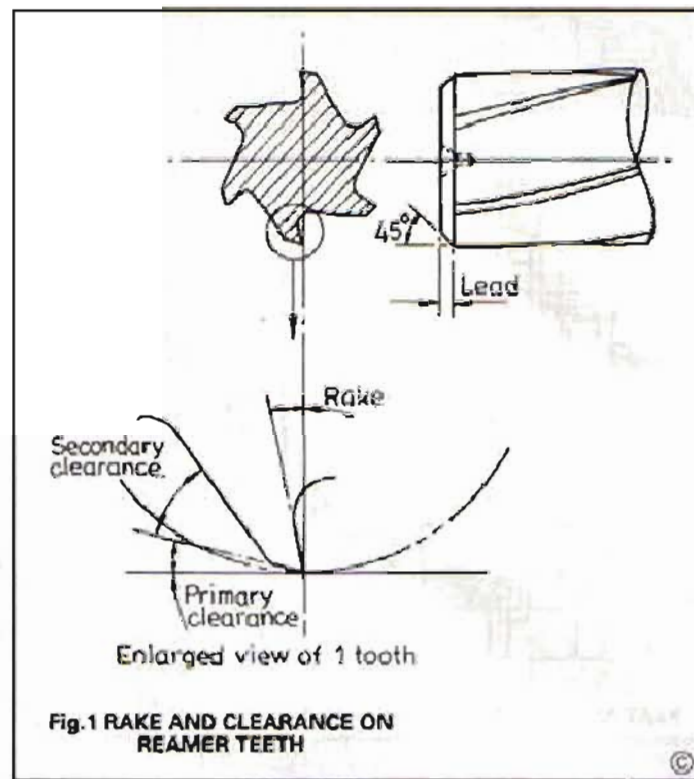


Fig.1 RAKE AND CLEARANCE ON REAMER TEETH

Fig. 1. also shows the shape of the tooth enlarged and it has the same rake and clearance as any other cutting tool. Secondary clearance is there to provide a cutting land and easy machining for the form cutter which cuts the teeth. The flutes can be straight or have a left-hand helix. Straight ones can cause problems with chatter on some metals, but are good for hard brass and cast iron. The helical ones are better for the more ductile and softer metals, like copper and mild steel; without getting too technical, the helical ones cut with a diagonal slicing action which suits ductile metals better. One solution to the chatter problem is to space the reamer teeth unevenly. As long as there are an equal number of flutes, they can be spaced, one big, one small, and so on. This breaks up the pattern of sympathetic vibrations, which is one of the many causes of chatter.

Other types

There are three types of reamer which are a bit out of the ordinary.

Tapered

Used for reaming out holes for taper pins and made to the standard taper pin taper. They have to be used carefully, especially in the smaller sizes. Some taper reamers have no teeth as such but are pentagonal in cross section and cut on the corners. They are very long for their size, used by hand and make a lovely job of taper pin holes. To give some idea of what they are like, the smallest one I have is

0.040in. at the small end, 0.89in. at the big end and 2 1/2in. long. I have always known them as Lancashire broaches.

Adjustable

These are expensive and cover a range of sizes. They start at about 1/16in. and I have seen them at least 1in. nominal size. They have a range of 1/16in. or more, depending on the size and the adjustment is done by sliding blades up and down tapered slots which are machined in the reamer body. The blades are a matching taper so that as they move along, they expand or contract. Nuts at each end of the blades both adjust and lock when the size is right. The nuts have an internal cone which retains the blades.

They are sometimes called expanding reamers and are set by carefully measuring across the blades, or by the 'cut and try' method. I have only known the hand ones with the taper and the square on the shank, but there are probably machine ones too.

Shell

The larger any tool gets, the more it will cost because of the cost of the steel. To cut costs and reduce storage space, larger reamers are made as a shell which fits on a standard arbor with a Morse taper. The shell has an internal taper to match one on the arbor and is locked by a short screw or a pin. The length is short, about 1 1/2 to twice

machine a non-standard hole or one of an unusual shape? The answer is to make one and it will usually be a 'D' bit because they are the easiest solution. They have been around for a long time and are very useful tools. Fig. 2 shows the shape and details. They will cope with most materials, are easy to make and produce holes as accurate and well finished as reamed ones at a fraction of the cost.

The name 'D' bit describes them exactly, because the cross section is a D made by cutting an accurate diameter in half. The thickness of the D should be the radius + 0.005 in.

The diameter usually has a tapered lead and the finish on the diameter and the flat face must be good. The two clearance angles at the tip help the cutting action, especially if it is used for bottoming a drilled hole.

Making 'D' bits

Silver steel is the favourite material for 'D' bits, but if you have some round tool steel which is accurate enough, it can be ground half away, measuring carefully and stoning the cutting edge. I have made such cutters in about ten minutes, it's that easy. Another option is the standard punches used by toolmakers for inserts, they can be made by grinding too. Be careful to use the right end of those, because one end is left soft.

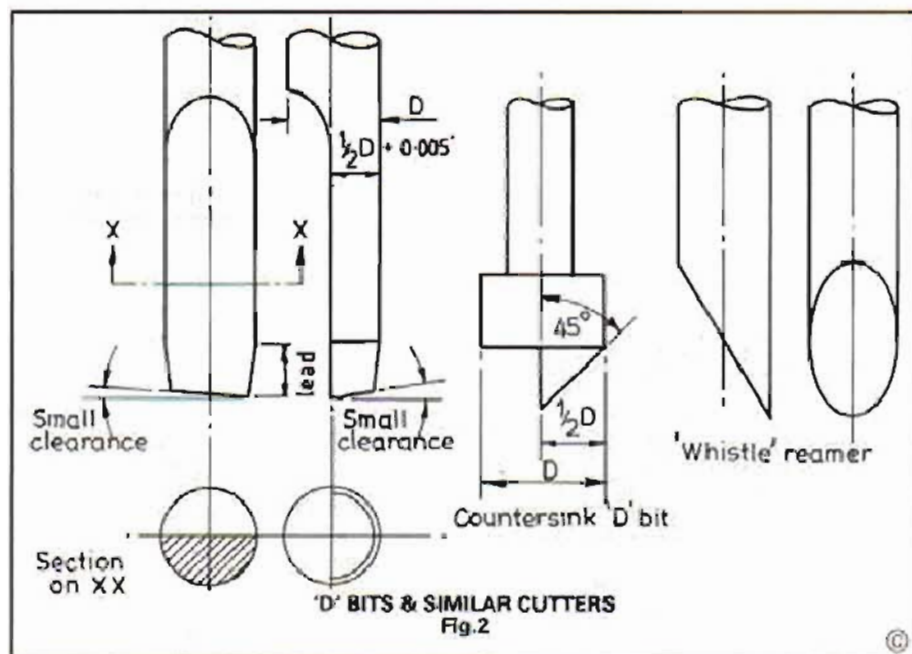
If the material to be cut is soft, like

or paraffin. Then cut half away for as long as you want and try to get it to the same finish, using an oil stone for the last little bit.

To harden, forget about cherry red and all the other descriptions of the colour, just heat it up till it is red hot and *starting to scale*. The scaling or blistering is the clue, when it scales, it's cooked. Quench in water, re-polish, and temper by heating the shank and letting the colours flow towards the tip. Straw is the right colour and it doesn't matter if the shank is brown, blue or whatever; its colour on the cutting edge is the one which counts. When tempered like this, there will be a gradual increase in hardness toward the tip. The quench in



Two 'specials' with the shapes they make.



the diameter and the main use for them is on large machines like horizontal borers. The rest of the design is the same as machined reamers.

Chuckling

A chucking reamer is the same as a machine one but the cutting length is much shorter, although the length of the shank is as long or longer than the standard one. The cutting length is about 2 or 3 times the diameter. They are used for deep holes and where a long reach is needed.

Home-made reamers

It is lovely to have a selection of reamers, but what happens when you break your one and only or have to

synthetics, mild steel will do, but not for large numbers because it soon loses its edge. I once knew a chap who made them from hard brass for cutting Tufnol and I know it works because I once had to make a tap to clear out some threads in large Tufnol bezels. There was no chaser and no steel large enough to make a tap from. The only material to hand in the size wanted, was some hard brass and it worked a treat.

It is best though, to be conventional and use the right metal for the job. Silver steel is ideal, for the range of sizes, the ease of turning and filing and the excellent hardening properties. Use stock size if you can but if you have to turn it, the finish can be improved by first using emery cloth, backed by a file to keep it flat, then a fine oil stone at high speed with a touch of thin oil

water is all right for all but the largest sizes and those with an abrupt change in section, for these oil will be better and don't worry if you haven't got any proper quenching oil, I use some old sump oil (if you do this leave it open to the air to allow any petrol etc. to evaporate - Ed) with no ill effects.

After tempering, stone the flat and remember, the finer the finish on the tool, the finer the finish on the job. You will be glad at this stage that you didn't leave too much to stone off because it takes a long time to move even a ten-thousandth with a stone.

There are many uses for 'D' bits and the photographs show a few. Photograph 1 shows several straight ones used for reaming, sizes from 1/16in. up. No.2 is two specials with the shapes they make, a venturi for a model aero engine carburettor and a hemisphere for a moulding tool for fishing weights. No.3 is two tapered ones and two curved. The curved one, third from left, was made very quickly from 1/16in. round tool bit, by grinding and stoning the curve, then grinding half away, as described earlier. Looking carefully at the shank of that one will just make out the S of HSS. Most of the 'specials' date from my fishing days and were used for making moulds for weights. The last photograph is of some more 'specials', the ones on the right are unimportant but the other two are 'D' bit countersinks, the shorter one like the one shown in Fig 2. The other one is a countersink with a very small angle and a pilot. All countersinks work better with a pilot, it's the lack of the steadying influence of the pilot which makes them jump about and chatter sometimes. Cutters like these are often made for a special job and it is a long time before the same job comes up again. 'D' bit countersinks work best on hard brass and cast iron, steel and the ductile metals need a bit more care and a slow speed. Slow speeds are the rule for any sort of 'D' bit on any material.

For shapes like quick tapers and spheres, some pre-drilling is needed because 'D' bits

are only really finishing tools. All the tapered ones and the spherical ones in the photographs were made by first drilling in steps as near to the finished profile as possible, then finishing off with the 'D' bit. Tapers especially need plenty of lubricant because there is a lot of cutting edge in contact. This can be a problem with small lathes and low powered drilling machines, so the speed may have to be reduced more than normal, to increase the torque.

Some jobs are tailor-made for 'D' bits. Those which need matching tapers, for instance, like the tapered hole in an expanding lap and the mandrel it fits on. Mandrel and 'D' bit blank can be machined on the same compound slide setting, then when the hole is reamed out in the lap, it fits the mandrel exactly.

At times when I've had no alternative, I've used 'D' bits for light milling jobs. They are very similar to engraving cutters, both

For speed and feed, it is half the speed and twice the feed. This means half the drilling speed for the material and size. Feed doesn't matter so much because it is something which is felt and it is unlikely that it will be too quick — too slow is more likely, which does no harm.

The other rule about the reaming allowance, the amount left on for the reamer to take out.

The correct allowance to leave is 10% of the reamer diameter. So for $\frac{1}{8}$ in. it would be 0.050in. for $\frac{1}{4}$ in. it would be 0.025in. and so on. Using this allowance will avoid embarrassments like I once had when I drilled a $\frac{3}{8}$ in. hole and tried to ream it with a 1in. reamer. It went through without touching the sides or cutting anything. So stick to the 10% rule for reamers, 'D' bits and any other cutter which does the same job. It gives the cutter something to get hold of, without expecting it to do too much.

when reaming phosphor bronze, a notoriously awkward metal which has a habit of getting very hot very quickly and shrinking very quickly, usually to grip the reamer very tightly. If it is a blind hole, and it usually is, tough! All you can do is wait for it to cool down if it is hot, flood it with light oil and clamp as much of the reamer as possible in a vice, with soft jaws, and try to tap the job off it. If it still won't shift, walk away whistling and make another one.

If you have problems with chatter, reduce the speed and wind it three times as fast through the work. One of the causes of chatter is too fast a speed and another is too slow a feed. If it still chatters, try wrapping some card round the reamer shank before putting it in the chuck. Don't overlap the card or you will throw the reamer off centre. It sometimes works by damping out the vibrations which cause the chatter.

If very thin tubular components have to be reamed, leave the outside diameter large, do the reaming, then turn to the finished size. This will help to prevent chatter. If this isn't practicable, wrap some Plasticene round the job, if you haven't any Plasticene use string. I have dwelt on the business of chatter a bit because I have had problems in the past with it and I'd like to think that I may be able to help someone with the same trouble.

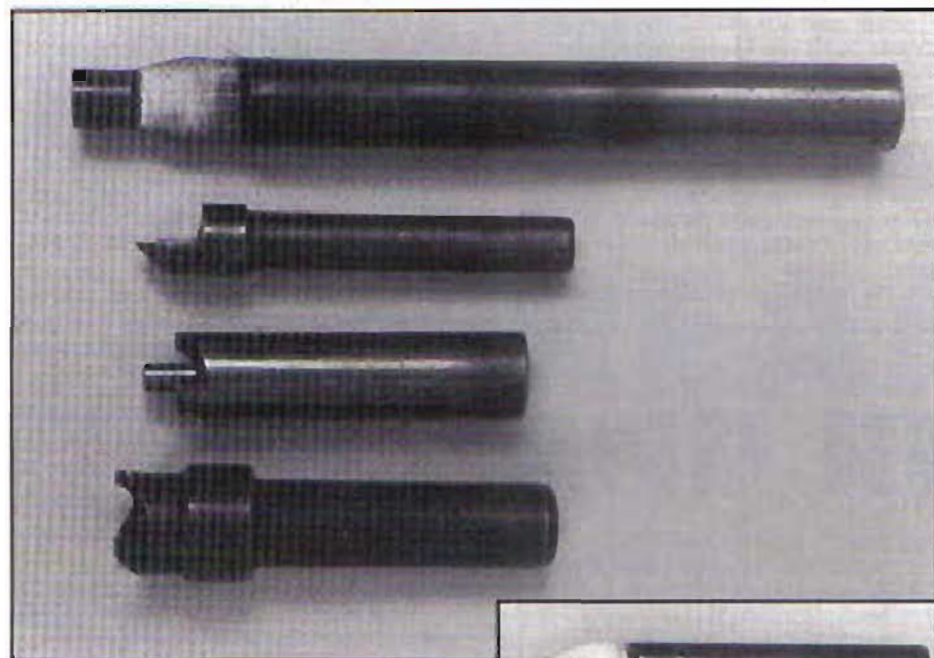
Reamers come into their own when two parts have to be dowelled together or fastened by fitted bolts (a fitted bolt is one with an accurate plain portion which locates).

For parts which are located by dowels it is usual to have the dowel a slight interference fit in one part and a sliding fit in the other, so that when they are unclamped, the one will lift off, leaving the dowels in the other. It is done by using a hand reamer and, with both parts clamped in position, reaming through till the reamer pokes through about $1\frac{1}{2}$ to 2 diameters. This will give the sort of fit needed for both parts. If, by accident, the reamer is taken too far or is a sliding fit where it shouldn't be, it can sometimes be remedied by tightening the hole. Do this by placing a steel ball, larger than the hole, over the part which needs tightening and pressing in a vice. It will usually close the hole enough to grip the dowel. Do not attempt it if the part is hard. In this case, use a soft dowel and lightly knurl it. Engineers sometimes bemoan the lack of a 'putting on tool' for mistakes like sloppy dowels. A knurling tool is such a putting on tool, which will increase a diameter enough to do the job. It should be used where the knurl will be hidden.

Reaming follows the same rules for cutting speeds as other tools; slowest for stainless steels, high tensile and alloy steels, then cast iron, mild steel, brass and bronze, with aluminium and light alloys needing the fastest. The three which ream best are hard brass, duralumin and cast iron, but with care and following the simple rules, reaming should be no trouble.

If I've missed anything out, consult a good reference book, there are plenty on the market and they will also give chapter and verse about speeds, and probably more simple rules to make the job easier.

The best of luck with your reaming, may all your reamed holes have a finish like glass and be dead accurate.



Above: Tapered and curved 'D' bits used for making moulds. Right: 'D' bits used for countersinking.

in shape and cutting action and the engraving process is used for light copy milling and die-sinking, so I was only following accepted practice.

If you haven't tried them before, do so next time you have a hole to ream. You will be surprised at how effective they are: easier on the pocket too, because you can make 30 or 40 for the price of one shop bought reamer and it isn't such a crisis if they get broken, worn out or lost.

Whistle reamers

A whistle reamer is even easier to make than a 'D' bit, just a length of silver steel, cut off at a shallow angle as shown in Fig 2. It is filed smooth, hardened and tempered and re-stoned nice and finely. They are said to work well and I have experimented with them, but I cannot remember the results, so I will have to pass and not give an opinion. As they are much simpler to make, they could be well worth a try.

Ways and means

There are some general rules about reaming.

Those are the main things to remember, most of the other ones are common sense, but some are not obvious.

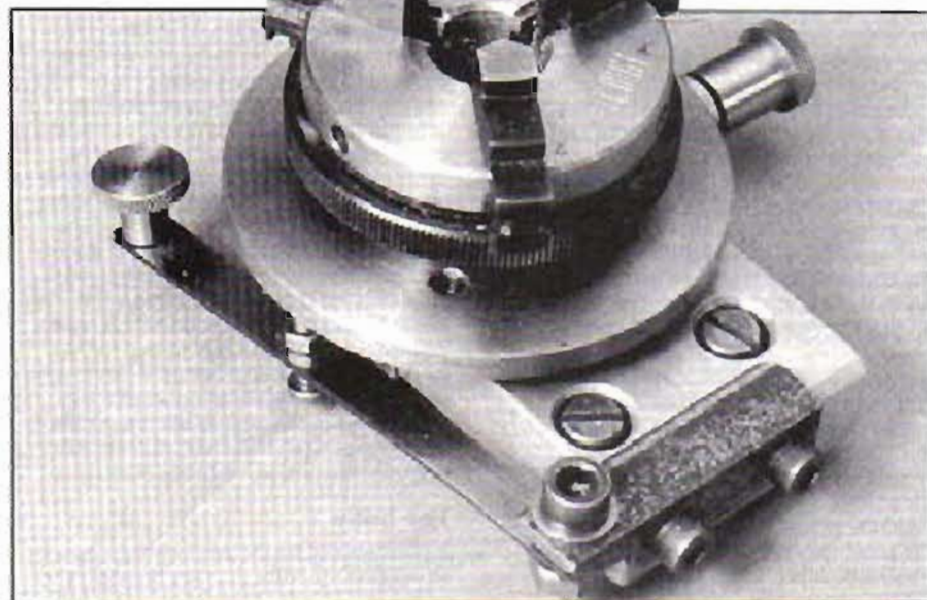
A reamer will always follow the line of the drill and there is no way it can correct mis-alignment, so if it is important that the hole is true, bore it out to the 10% less, then ream. This is, of course, for turning. For other operations it is vital that the drilled hole is true and in the right position.

When using a reamer by hand always turn them clockwise, even when withdrawing, otherwise they will rub and do the teeth no good. For the same reason when reaming by machine, never reverse the machine.

If a reamer gets stuck, which is always a possibility, put a punch through from the back and lightly tap it out. It can happen



DIVIDING ATTACHMENT FOR THE UNIMAT 3



The completed Dividing Attachment fitted with the Unimat lever scroll three jaw chuck.

D. J. Scoggins made this dividing attachment on his Unimat 3 lathe, obviously for use on that machine, but it could be made for use on any lathe or vertical miller. Please read on – if only for details of the little discussed method of cutting threads on the lathe.



The Lantern Pinions which created the need for the attachment.

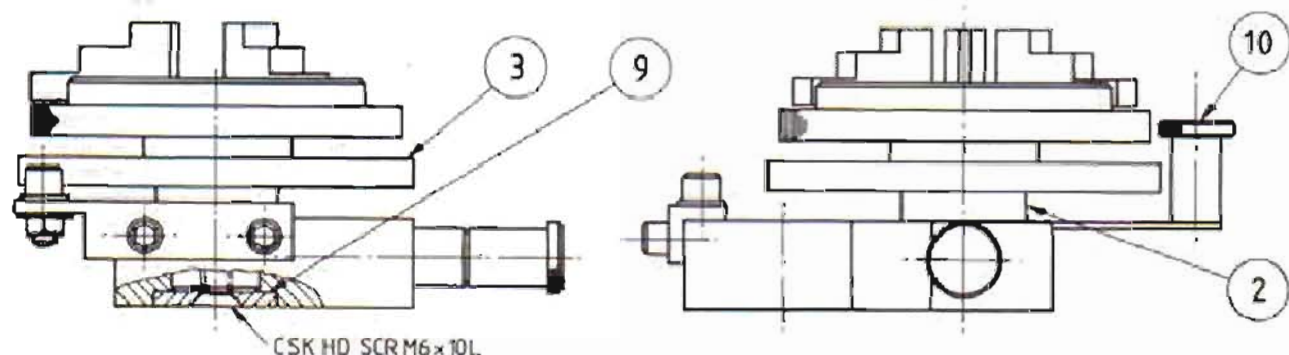
I was recently making a clock and came to the stage where it was necessary to produce a lantern pinion specifying a series of holes equally spaced on a $\frac{1}{2}$ in. rad. with another set on a 0.235in. pcd, these can be seen in **Photograph 2**. As this was my first venture into the field of clockmaking it was decided that I should have a rest to see what could be produced to assist in this matter. I had several options open as my workshop boasts among other things, a Black & Decker drill c/w stand, a small bench drill, an excellent assortment of hand tools, a Sin. Raglan and of course the Unimat 3 lathes. Much careful thought and consideration was given to the matter and it was finally decided that the honour should be bestowed upon the

SOC HD CAP SCR M6 x 15 LG
M6 NUT

2 SOC HD CAP SCRS M5 x 10 LG

M4 NUT

GENERAL ARRANGEMENT
DIVIDING ATTACHMENT FOR UNIMAT 3



Unimat. There were several influential reasons for arriving at this conclusion.

1. Horses for courses. Small machine small component. I am a firm believer in the old cliché that if something looks right it probably is right.
2. If the spindle used is an exact replica of that part of the Unimat then the workpiece can be transferred between the two without the necessity to reposition it each time.
3. I had already started to make a similar dividing attachment so it justified the time and gave the opportunity to make slight modifications and to complete it.
4. The job is presented to the cutting tool at the best possible attitude as it enables them both to be seen easily, especially as failing eyesight due to advancing years is rapidly taking its toll.
5. Toolmaking is my pride and joy as I feel that I have achieved something, usually resulting in a superior article at a great reduction in cost.
6. Provides positive, accurate, reliable and repeatable indexing. Having more than two rows of holes was tried, but as the detent was partially obscured it was felt that two is just about right. After all, it is only a matter of using the other side of the plate to accommodate them if the need should arise.

All dimensions contained in the article are expressed in metric (mm.).

The manufacture of the components should be carried out in the same order as written, because of the necessity of using some of the parts already made as gauges.

The Mandrel

The Mandrel is made from 22mm BMS, for reasons of cost and availability. With correctly sharpened tools it is easily handled by the Unimat and also it will work well with the aluminium body as no bearings are provided or considered. Much thought was given to the manufacture of the spindle, especially the screwcutting, and the conclusions which I arrived at are listed below:

Screwcutting

I did not want to outlay a vast amount of hard-earned cash on the Unimat set up; after all, one of the reasons for manufacturing this piece of equipment is to save the 'stuff', it might not be used once the job had been completed. However, for about £10 I could buy a 14mm die nut but for reasons already stated ruled that out.

All of the threads used in the construction of the Unimat are of 1mm. pitch. It occurred to me that an M6 thread is of the same pitch also the design of the mandrel calls for that size to hold it in position. With this in mind the problem virtually solved itself.

Making a start

Before making a start on the mandrel it is required to make a packing piece, tapped plate, and screwed rod. Saw off a piece of 10mm. thick x 38 x 38 aluminium and another 28mm x 38mm. The lathe is now prepared by squaring up the toolpost with a rule held tightly against the face plate then with the toolpost loosely in position butt up against the rule tighten securely. The faceplate is removed and its position taken by the drill chuck. Mount the 38mm x 38mm piece of aluminium on the opposite

side of the toolpost to that where the tool is normally fitted, refer to diagram, and hold this in place with a clamp having 10mm overhanging.

Centre drill and follow this up with a 5mm drill, which in turn is replaced by a 6mm taper tap and is taken right through the component. This piece of material is removed from the Unimat 3, the 3-jaw chuck is fitted complete with 60mm of 25mm dia. bms. The end is faced and the component is reversed in the chuck and this end is faced and centre drilled and then drilled and tapped M6 to a depth of 10mm. Take a piece of studding 50mm in length and screw the first 10mm into the partially completed mandrel. Spin an M6 locknut onto the studding and tighten securely. Centre the end of the studding enabling it to be supported by centre. Bring the centre into use and with sharp Rh & Lh tools with the corners slightly stoned off press on and finish the mandrel. Leave the excess length on the 18mm end which will suffice as a gauge.

Fit the screwcutting tool with just sufficient overhang, and use a screwcutting gauge to get the tool square to the axis of the machine. The cutting tool is now wound to a position where it is just beyond the start of the cut, the tapped plate is carefully twisted into place, not forgetting the packing piece which fits between the threaded plate and the toolpost. Disengagement of the lathe feedscrew is the next consideration and this is achieved by using a 3mm Allen key, slacken off the 6mm grub screw located underneath the boss next to the handwheel of the feedscrew. With this loosened it is possible, by turning the feedscrew, for it to be wound out thereby freeing the saddle.

The final thing left to be done, now that the saddle is free, is to fit the clamp holding the tapped plate in position so that we get the drive to the saddle when the lathe is set in motion. As the machine is propelled by hand, for safety reasons it is advisable to remove the driving belt and to disconnect from the mains supply. Having made our Unimat safe we are now ready to make a start on the screwcutting operation. Wind the tool until it just makes contact with the job, bring the tool clear and advance by two divisions. Turn the mandrel by means of grasping the pulley and imparting motion; the tool will progress towards the headstock, cutting the thread of the required pitch as it goes. It is time to stop when the tool reaches a position 3mm from the shoulder; the tool can now be wound back to the start position. It was found that there was nothing to be gained by winding the tool away from the workpiece at the finish of each cut. Slacken the clamp, wind on a cut, trying about two divisions; after a couple of traverses it is possible to find out exactly by how much to wind in the tool so as not to take too large a cut thereby making turning the machine by hand uncomfortable. Tighten the clamp and carefully wind the cutter along its path until it reaches its predetermined point of 3mm from the shoulder.

The tool can be returned to the start position, clamp slackened, cut wound on, clamp secured and the tool moved along the workpiece, etc. This can now be repeated until the thread looks about right when the tool can be traversed off the thread of the studding until it is possible to try the thread for size or perhaps the

faceplate. If more material has to be removed, as most likely will be the case, it will be necessary to re-engage the studding into the screwed block, wind it back to the starting position, place a cut, place the clamp in position, tighten and continue winding. Repeat until a satisfactory fit is obtained.

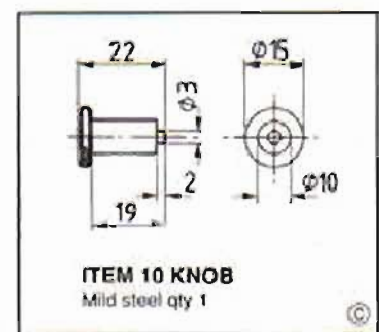
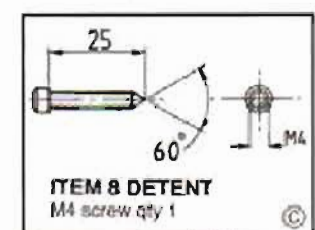
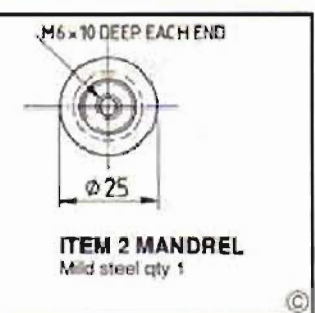
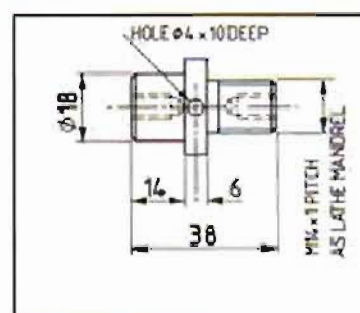
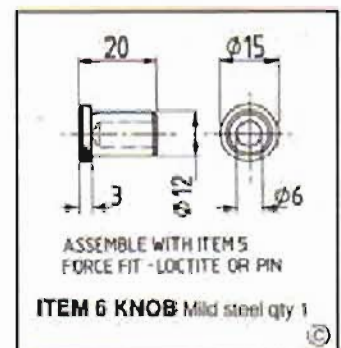
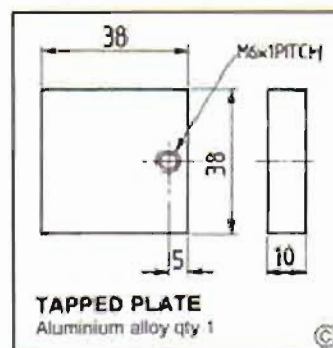
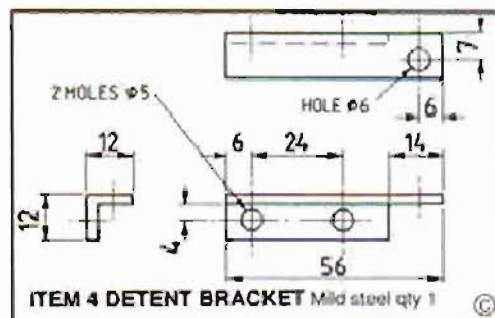
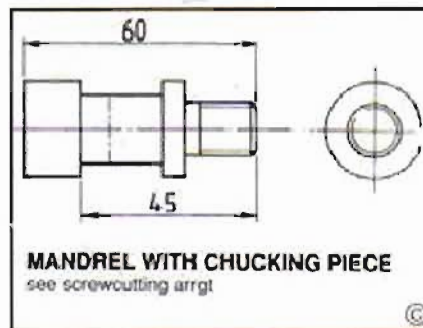
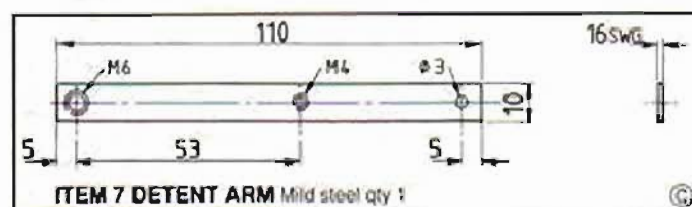
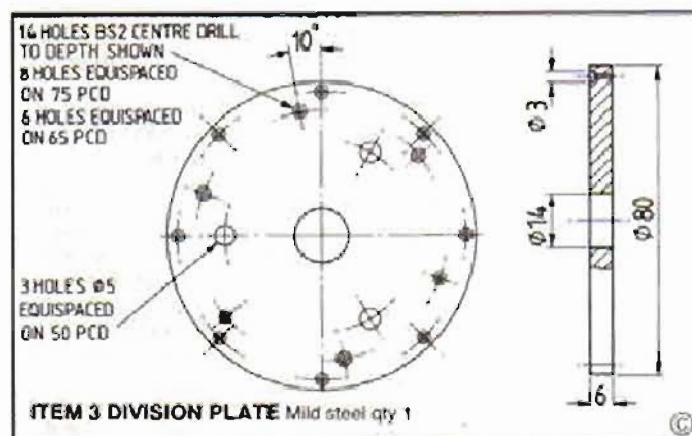
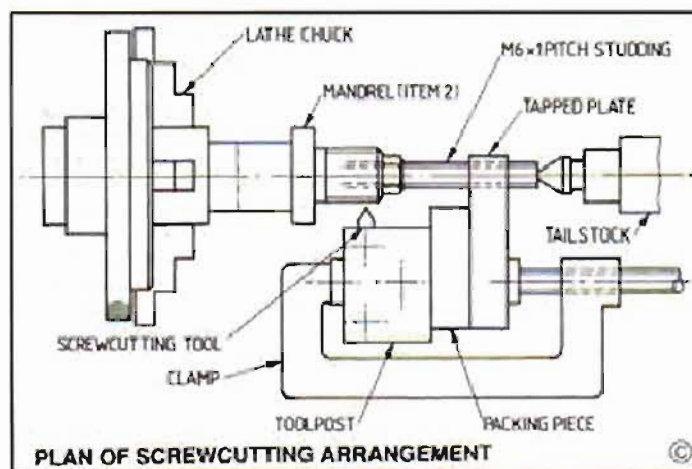
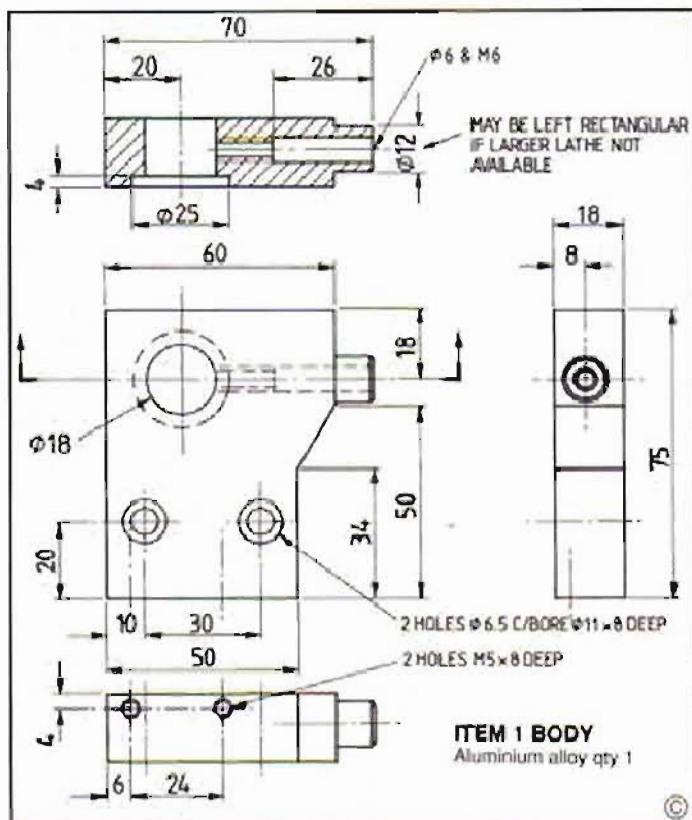
The workpiece can be polished at this stage and the sharp corners can be removed. It can now be taken from the lathe. Reverse in the chuck, protect the thread from the jaw marks and consequent damage by wrapping a piece of emery or other suitable material around it. The component should enter the chuck with the shoulder butting against the jaws. The surplus bit of material can be hacksawed off and put to one side and our attention turned to finishing off the mandrel. The length is tackled ideally arriving at about 14.5mm. This will permit the length to ultimately be reduced to suit finished size of the body after counter boring. A centre drill followed by the tapping size for M6, 5mm drill is taken to a depth of 20mm and finally tapped. We could finish off the mandrel completely by placing it on the drilling machine to put in the 4mm hole; just to break through into the bore.

The body

This should be the next piece to be attempted. Aluminium alloy was selected as the material from which to make the body, because when I come across a piece of useful material it is always snapped up by yours truly, placed in a corner of the workshop and a mental note made as to what it will be used for! It measures up 75mm x 75mm x 18mm thick which is just about the right dimensions. I would recommend that you try to obtain a piece of that material to the specified size, but if it is not available an adjustment could be made to the length of the mandrel or the aluminium could be fly cut to the correct measurement.

Aluminium is a good material for running in direct contact with the mild steel mandrel; it can easily be worked, a good finish is easily obtained and a similar material is used by the makers of the Unimat. Mark out the two counterbored holes that will accommodate the cap head screws which will hold the finished article onto the cross slide - also the position of the 18mm hole which will house the spindle. Take the body to the drilling machine and drill and counterbore the two holes and the other hole to about 12.5mm - as long as there is enough meat left in the hole for the final sizing operation on the Unimat later on. While on the drill we might as well mark out and put in the hole for the nylon drag on the side of the component. It just leaves us to mark the outside and to file to these lines.

Fit the drilling attachment to the Unimat complete with a suitable boring tool. Secure the part to the cross slide in the same position it will occupy when it is completed and in use. Adjust the position by means of manipulating the handwheels so that the cutter will take equal amounts from each side of the hole when commanded to do so. Carefully move the tool in its holder so as to just take a very light skim out of the hole. After the cut has been taken, stop the machine and measure. Adjust the tool to cut more material from the bore; about 1mm is comfortable. The



tool is moved by slackening it off slightly and tapping it forward with the aid of a hammer and punch. Tighten and take a trial cut of about 1mm. Continue with this cutting and measurement until the gauge that was previously made will enter. Follow this by making the counterbore for the retaining washer in the same manner. Remove the component from the Unimat; all that remains is for the spigot around the lock screw housing to be rounded off. If you are solely dependent upon the Unimat as the main machine tool used for the manufacture of this dividing head it may present a slight difficulty. The spigot is purely for decorative purposes – it has no bearing on the functioning of the instrument – but it is called for and it gives the item a professional look so I would attempt to include it as a feature even if it means taking a series of files to complete the task. It is not until one tries and practises that you find how capable you are and of course improving one's ability at the same time! I must admit to a bit of cheating at this stage by using my Raglan fitted with the 4 jaw chuck. If you have got the tools, why not use them!

The dividing plate

Mild steel was again chosen for this part, because it is readily available, easily machined, can be easily brought to an acceptable finish and is reasonably tough enough to accept a small piece of rough handling. The method of construction may be a little unconventional e.g. why not use the popular solution of change wheels? I will explain.

SOLUTION BY SIMPLE TRIGONOMETRY
Taking the distance between one of the eight holes and the next hole be x mm as illustrated on 75pc

$$\sin 22.5^\circ = \frac{x/2}{75/2}$$

$$\sin 22.5^\circ \times 75 = x$$

$$x = 28.70 \text{ mm}$$

3 Holes on 65PCD (As made, see postscript ED)

$$\sin 60^\circ = \frac{x/2}{65/2}$$

$$\sin 60^\circ \times 65 = x$$

$$x = 56.3$$

Conclusion: The dividers should be set so points are 28.70mm apart for 8 holes and 56.30 mm apart for the 3 holes. (32.5 mm for 6 holes. Ed)

Being a regular subscriber to *MEW*, I usually try to devote the occasional Sabbath, as a change, to making small, simple and quick items that I think will be useful to have and one such item was about converting my faithful vernier for the purpose of marking out. Especially as by looking at the photographs published within the article it was the same type as I own. I got carried away with this excellent piece and I believe that quick job took me the best part of a week to complete, thanks to Mr Lammis!

Why not try this new tool out by using it to help in the production of the dividing plate? Also perhaps some of our readers, possibly newcomers to this engineering game, have not got the added luxury of change wheels. Also as a boy I used to like to mark out and drill a series of holes in this manner.

The first task is to acquire a piece of 6mm MS plate of just over 80mm in diameter, also a piece of 16s.w.g. sheet metal suitable to have a trial run at the marking out as even with the aid of a decent calculator there is a certain amount of wrangling and usually it takes a second attempt to perfect.

Coat one face of each of the pieces of material with marking out fluid, and find the centre of each piece, possibly by drawing diagonals. Centre pop this position.

Just a word about sharpening of the centre punches that will be used for the marking of the hole centres. I have found by practical experience that a punch to be used for that purpose ...

1. Must be really sharp.
2. The end to be ground concentric.
3. The end ground to a much steeper angle than that of 60 degrees which of course is the usual.

It goes without saying that a punch that has lost its point is useless. The point being sharp and of a steeper angle enables the punch to function more like a scriber if it was to be used for fudging around the intersection of the lines – it should be physically possible to feel that the punch has picked up the position by its tracks, the lines of intersection act like railway lines guiding the punch. Firstly the point is placed in the circle representing the PCD then continued around towards the other line which it is felt to engage. Then, without moving the punch, it is sighted up by eye to make sure that it is perpendicular to the work and then a light blow with a hammer is imparted. I have a series of small collars, one of the uses for which is sharpening the punches. A collar is fitted to the hammer struck end of the punch and it is placed on a suitable vee block with the collar overhanging, limiting the position of the punch. The set up is taken to the grinder, the angle estimated and the punch is consequently ground. 25 degrees for the steeper angled and 60 degrees for the normal punch which is used after the steep one to mark the position of the holes to give a good start to the drill, ensuring that accuracy is maintained.

Back to the division plate, the piece of MS measuring just over 80mm x 80mm x 6mm. Set the vernier to scribe a circle of 70 PCD, mark this circle, resetting the instrument to scribe a further circle of 50 PCD. Also mark this on the dividing plate. Next items that are required are three 5mm set screws of sufficient length to be

assembled in the following manner – the setscrew passing through the division plate, M6 nut, lathe faceplate all secured with an M5 nut. The division plate is laid with the scribed circles uppermost, the three M6 nuts are placed equally spaced around the 50mm circle and the faceplate is rested on the nuts, interposing them between the plate and the faceplate, the M6 nuts should be visible through the three apertures in the faceplate.

By using a scriber or such through each of the apertures in turn, manoeuvre the nuts so that when a 5mm drill is passed through the centre the threaded part of it is clear of the sides and top of the aperture the point on the 50mm circle. The parts can now be securely clamped together, and checked that they are still in the correct position and they have not moved. Place the 5mm drill into the chuck of the drilling machine and machine the three holes by passing the rotating drill through the threaded portion of each nut in turn. Remove from the machine, brush away the swarf and place a 5mm setscrew in each of the holes, securing with a 5mm nut. The clamps have served their useful purpose so they can be removed. The face plate can now be introduced c/w division plate to the Unimat.

Another of my Sabbath day escapades took place concerning the manufacture of a boring tool from a piece of square bar with the tool part being a No.2 centre drill. That is what I call a real quicky. Thanks once again to *MEW*. We really get our money's worth!

With this useful tool installed it is now possible to machine the central position of the dividing plate using the slowest speed and again limiting the cut to about 1mm. The thread portion of the mandrel is used as a gauge, aiming for just a nice snug fit between the division plate and the spindle. An aluminium bung was machined at this stage such that the 14mm dia. is a slight interference fit with the centre of the division plate and the centre of the bung was outlined with just the lightest of touches with the smallest centre drill that was available to me. The division plate was detached from the lathe faceplate. The bung was tapped into the centre hole. Careful adjustments to the vernier, using an eye glass if necessary, are set to scribe circles of 80, 75, 65mm. They are marked on both plates.

Working on the 16s.w.g. MS sheet for the present, mark anywhere on the 75mm PCD with the steep dot punch, carefully feeling the punch dropping into the PCD and checking that the punch is held in the upright position before it is smitten with the hammer. We are now aiming for eight holes, so looking at the calculations for that particular series set the vernier to that dimension, using the eye glass if necessary. With one of the points securely embedded in the dot, traverse the other point of the vernier to make two incisions each side of the original hole centre at this setting. Still using the steep centre punch carefully pop the position of these two holes. Put the point of vernier in each of these centres in turn and swing it to cross the PCD and centre pop these two hole positions. Repeat until all eight of the holes are marked. Examine with the eye glass the accuracy of this circle of holes. It is more than likely that an error will have revealed itself by the position of the last

hole (denoted where the two arcs cross) will, in all probability, be above the PCD. The other alternative is that they will not even meet!

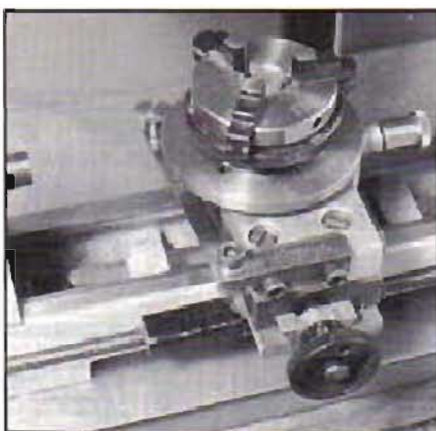
Assuming that we have an error as described I suggest that it should be resolved in the following manner. Adjust the points of the vernier to 'pick' up the centres of the last two holes, and then subtract from the original figure from the calculations. The resultant should be a fraction of a mm; take this fraction and divide it by the number of holes, in this case eight. Depending as to whether the measurement used for setting the vernier was too long or short we either add or subtract this minute amount to the original setting. The vernier is reset to this fresh figure and all of hole placings are re-marked on the 16g MS sheet. Only then can the 6mm MS be marked. I am quite confident that they will be correct the second time around. The same method is used for marking the three holes. Before transferring the markings to the division plate just take care as to where the first hole is sited in order that it is positioned well clear around its correct PCD of 65mm so as not to touch the chamfer of the ones on the 75mm PCD.

With the normal angled centre punch go carefully over all the dots, keeping it upright to ensure that each and every hole has a firm mark to start from. A No. 2 centre drill is now placed in the drilling machine and the depth stop is set to limit the drill to leave the division plate when the holes are measured across the tops with a rule - approx. 3mm seems just right. With the stop set, the division plate can be transferred onto the machine and drilled. The purpose of the other two PCDs is as follows. The 70mm is for the siting of the faceplate - I am sure that I failed to mention it earlier on! - and the 80mm PCD is of use to denote the outside diameter. I had made my mind up by this stage to finish off the outside by sawing and filing carefully to that line. This can be carried out at this stage.

My reasons for reaching this decision are plentiful but here are just a few, the first being a glutton for punishment and also as an excuse to keep my hand in with a file. Secondly the Unimat is only a light and small machine and turning 80mm is an enormous task to perform as it represents a very large peripheral speed especially in MS. Although the little workhorse is capable it is a rather slow and painful process. Finally, the third reason was that the original genuine belt had broken yet again so I would have been forced to bring on the substitute of my Hoover washing machine driving belt!

The detent bracket

The detent bracket is made from a piece of 12mm x 12mm x 3mm MS. The main reason for the choice is that, in my opinion, it is the best material for the price and also all of the materials selected for this exercise came from my scrap box. Once this part has been manufactured it can be installed in place on the body. It is held in position by 5mm cap head set screws. One important point to watch out for is that at the end of the body where the angle overlaps there is sufficient radius to allow it to sit. It may need a little relief with a file to clear satisfactory.



Fitted on the lathe complete with a three jaw chuck and ready for use.

The detent arm

This is again MS for the following reasons - cheapness, ready availability and, provided that it is adjusted correctly, it will perform its duty admirably. It is also quite elastic within certain limits and remains so. A piece of 16g MS strip is required, perhaps a piece of the sheet material that was used for the marking of the trial for the indexing plate. If a portion is used from the above-mentioned source may I humbly suggest that it is marked out and drilled before the component is separated from the parent material?

The detent

The detent is a 4mm cap set screw of sufficient length to allow two locknuts to imprison it in position in the correct place.

The knob

The knob is again MS for reasons stated before. It serves no purpose other than to provide a means of altering the position of the component that is being worked. Although it is purely cosmetic it does finish off the tool and imparts a look of professionalism so I would recommend that this is made and fitted. Use the drilled hole in the indent as a gauge.

The nylon drag

The name gives away the choice of material but if none is available I would not rush out and try to buy some as a small length of aluminium or soft brass will be a good substitute.

Make it sufficiently long so that the length can be adjusted in order that the tap between the operating knob and the body is kept to a minimum where the latter is tightened. This part is essential to lock the device once the indexing process is underway. I like to wear a belt as well as braces if it saves the scrap rate!

The bolt

The bolt that holds the indent arm to the fixture is just an ordinary 6mm cap head set screw with a washer fitted above the arm and one prior to fitting the nut. Please do not have the bolt too long; saw it off just beyond the nut and finish of the end with a light chamfer.

The simple dividing fixture in use

There is not a lot in the way of operating instructions to be given, apart from saying that when changing from one lot of holes to the other I consider it well worth the time it takes to detach the fixture from the machine,

slacken off the indent arm, make the necessary adjustment, retighten, test that all is in order and position and secure it in place on the cross slide of the little machine.

This device was created for a special purpose which in my opinion it performs excellently. I deliberately kept the operation simple which in turn leads to a fairly easy construction. As already mentioned, more or less holes can be added by revising the division plate.

Perhaps it might seem a little strange as to the method that I choose for the set up regarding the division plate. However, for me this is purely a hobby with no boss apart from 'Her indoors' breathing down my neck!

Appendix

The reason for the errors in the setting of the vernier must be:

1. Error or carelessness in the calculations.
2. Error in setting of vernier.
3. By the fitting of 'square points' to the instrument - or possible combination of all three!

Taking one point at a time:

1. An error with the calculation is virtually impossible because I had them checked and the answers were compared, i.e. I did not know what answer my mathematician would arrive at until he had finished both calculations and then notes were compared. They agreed first time and we did not know what figure the other arrived at.
2. I do not consider myself infallible but I have considerable experience in the use and



The attachment seen without work holding device and with dividing plate removed. From this it can be seen how other plates and work holding devices, such as a face plate, can be fitted.

setting of the vernier and with this instrument in particular - it is a faithful and elderly friend - so I am confident that point two can be eliminated.

3. It must be point three, the square points by process of elimination. I manufactured three from snippets of gauge plate for two reasons; temporarily out of stock of round silver steel and also the diameter of such material must be allowed for when arriving at the actual figure to be calculated. I carefully re-ground the points and tried again - the error was just over 0.05mm on each point at this attempt.

Postscript

The drawings have been produced showing the dividing plate with rows of band 8, not 3 and 8 as the text, as this is considered to be a more useful arrangement. Ed.

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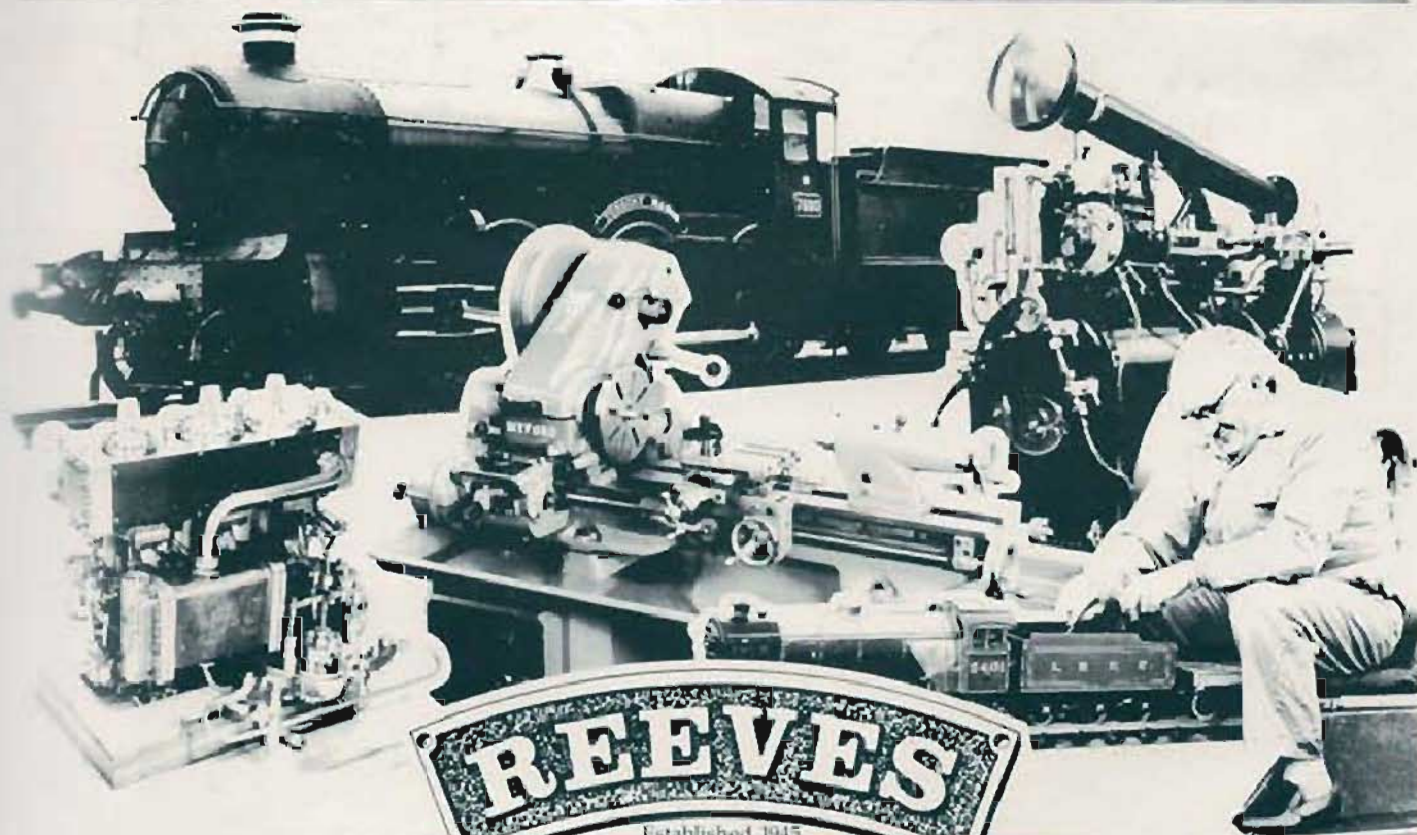
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